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ABSTRACT

Seventeen student worksheets form a secondary school unit which focuses on the challenge of shared usage of water resources. Pressure currently exists for a more balanced approach in which all legitimate interests in a water source are served. The worksheets include readings which focus on enough water for all, the water cycle (including a programmed exercise), power politics and hindsight, the selling of water, wetland areas, the new environment, the McGregor River diversion, the Alcan story, the Kemano Completion Project, the potential of the Stikline River, and water as a precious commodity. Charts of the world's water supply, British Columbia's major rivers, water balance graphs, and major hydroelectric power sites are also provided. Both readings and charts are accompanied by discussion questions. A brief test concludes the unit. (KC)

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SHARING BRITISH COLUMBIA'S WATER RESOURCES

A Teaching Unit for Secondary Schools

by

Angus M. Gunn

March, 1983

SP014636

Sharing British Columbia's Water Resources

The teaching materials in this unit are drawn from many sources. Proven classroom activities such as the programmed exercise of the water cycle are taken from the National Science Foundation's High School Geography Project; the McGregor Diversion simulation is taken from a larger kit of the same title, prepared by B.C. Hydro a few years ago; the newspaper articles are taken from the 1982 Vancouver Province Water Resources Series.

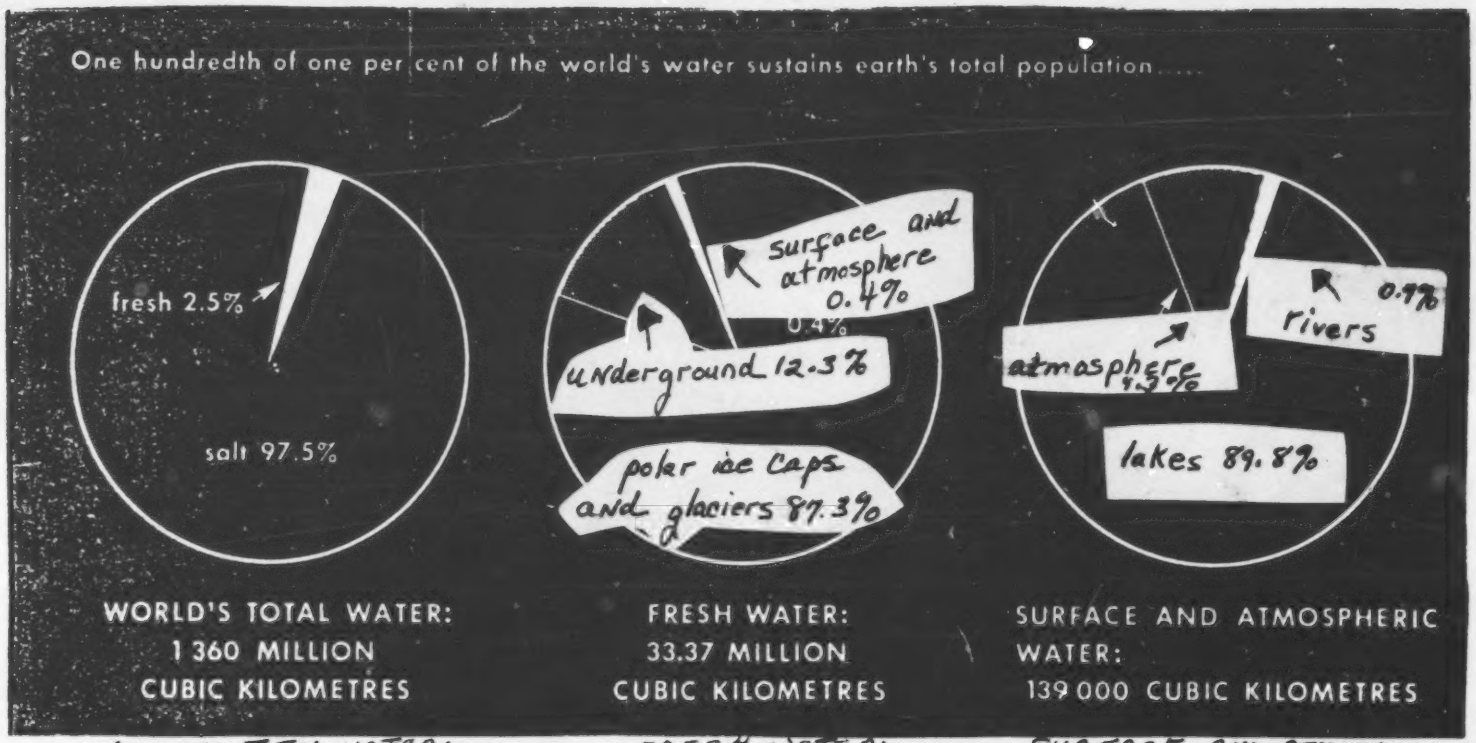
The common thread in all of these is the challenge of shared usage. In the history of water use, the concept of sharing has always been present in theory; in practice, in Canadian experience, one has tended to dominate. Now, in our increasingly complex and urbanized society there is renewed pressure for a more balanced approach in which, by mutual consideration and compromise, all legitimate interests are served.

The issues involved in water sharing can be tackled through such activities as debates, experiments, simulations, and library research. The materials in this booklet can serve as starters.

March 1983

Angus M. Gunn

One hundredth of one percent of the world's water sustains earths total population.....


One hundredth of one per cent of the world's water sustains earth's total population.....
fresh 2.5%
salt 97.5%
surface and atmosphere 0.4%
0.4%
underground 12.3%
polar ice caps and glaciers 87.3%
atmosphere 4.3%
0.7% rivers
lakes 89.8%
WORLD'S TOTAL WATER: 1 360 MILLION CUBIC KILOMETRES
FRESH WATER: 33.37 MILLION CUBIC KILOMETRES
SURFACE AND ATMOSPHERIC WATER: 139 000 CUBIC KILOMETRES

fresh 2.5 %

salt 97.5%

WORLD'S TOTAL WATER: 1360 MILLION CUBIC KILOMETRES

FRESH WATER: 33.37 MILLION CUBIC KILOMETRES

SURFACE AND ATMOSPHERIC WATER: 139 000 CUBIC KILOMETRES

1. What percentage of the world's total fresh water resources is tied up in glaciers and polar icecaps? If these ice masses could be melted down, gradually, over a long period of time, how much additional fresh water would be available?
2. What problems would be encountered in melting down the ice masses of the earth and what would have to be done? (Remember, most cities are located at or near sea level.
3. Canada'a lakes contain one quarter of all the world's fresh water. What volume of water does this represent? How much per person?
4. For every raindrop of fresh water on the surface of the earth, how many drops are underground? (Ignore the polar ice caps and glaciers.)

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Water: There's enough

By ANGUS GUNN

WATER, mankind's oldest resource. Elixir of life for it affects every part of our environment. It is everywhere: on the surface in the forms of oceans, lakes, rivers and icefields; below as groundwater; above, in the atmosphere, as water vapor.

In B.C. it is a resource that is all too familiar, even though some parts of the province have a near-desert climate.

In stream flow alone, B.C. has about 40 per cent of Canada's total and Canada has almost 10 per cent of the world total. So, proportionately, B.C. has more than 50 times its share of the world's runoff water resources.

Partly because of the steep terrain, the speed with which water flows off the land in B.C. is much greater than in other parts of Canada.

Hydroelectric dams have helped to tame this enormous surface flow so that settlements can be protected from flood hazards.

Water has been called the "mirror of science." Its properties of existing simultaneously in three states — solid, liquid, gas — coupled with the rare phenomenon of expanding when cooled beyond a certain point made it a reference point for scientific measurements.

Spring semester line-up

(Prepared with assistance from the following: Ministry of Environment, Government of British Columbia; Ministry of Fisheries, Government of Canada; Sierra Club; Society Promoting Environmental Conservation, Aluminum Company of Canada; B.C. Hydro and Power Authority).

(April 13 - June 15)

1. Water: Enough for all
2. Hydro megapower
3. Megapower politics
4. The new environment
5. McGregor diversion
6. Kemano completion
7. Stikine project
8. Water use
9. Water environments
10. Water for tomorrow

Water is odorless, colorless, tasteless. As a chemical compound it is extremely stable, the result of the way the two atoms of hydrogen and one of oxygen combine to form a water molecule.

The debate over priorities in water usage is a perennial one, sometimes sharply focussed in a polarization of views on what should be done.

In theory the notion of shared usage is widely accepted. In practice, it seems to be very difficult to establish priorities.

The growing concern over environmental quality appears to be a difficult priority to assess alongside that of the farmer, the fisherman, the forester, the hydroelectic engineer, the flood control expert.

"Water is a multiple use resource" reads a 1919 government of Canada publication on water conservation. It goes on to say: "We must not argue for single purpose use."

At the same time the publication adds "if we have to set priorities, then agriculture must have first claim on water." Since 1919 different priorities have surfaced, usually with inadequate consideration of lower priority uses.

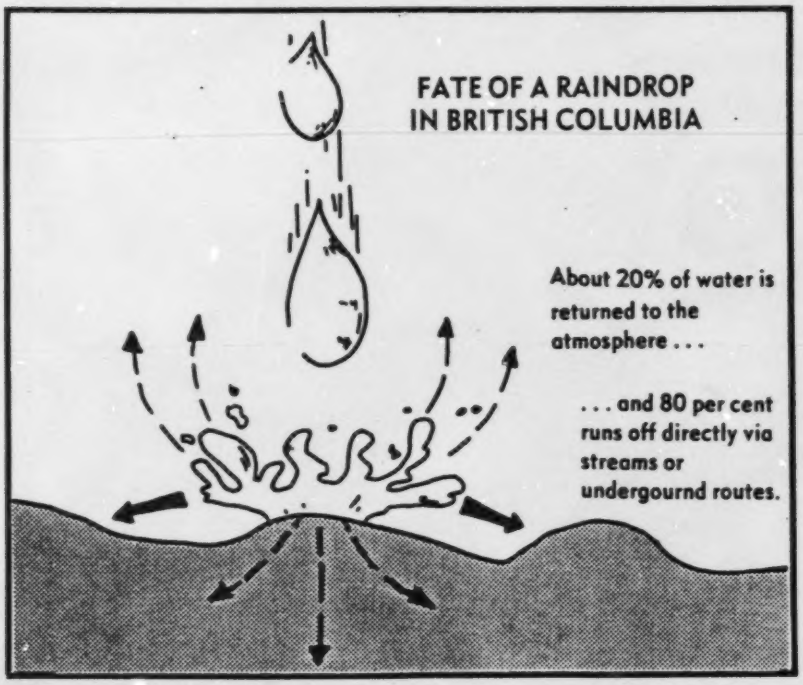
So the Columbia River Treaty of the '60s has been criticized for its neglect of wildlife and the lifestyle interests of those who had been using the valleys before they were flooded.

Energy, flood control and commercial fisheries seemed to be the main considerations in the minds of the treaty architects.

Multiple-use concepts had been receiving lip service only. The flaw in water-use thinking began to surface in the wake of the environmental movement of the '70s. Instead of visualizing mankind as an integral part of the natural environment, every human development was being treated as if it had been an invasion from another planet.

The beaver that builds a dam and disrupts other forms of life in the process, including mankind, was seen by the environmentalists as quite acceptable. But a hydroelectric dam; that's different. That's an alien element in the so-called natural environment.

Advocates of wildlife and recreational interests have, at times, overdone things and reverted to tunnel vision, single purpose arguments. "Freeze all of British Columbia's undeveloped areas; keep them for recreational use alone," ran the report of the keynote address to a 1980 conference of outdoor recreationists.


FATE OF A RAINDROP
IN BRITISH COLUMBIA
About 20% of water is returned to the atmosphere . . .
. . . and 80 per cent runs off directly via streams or undergournd routes.

for all

As we enter the '80s the 1919 dream of a true multiple-use concept is fast becoming a reality.

In 1977 the B.C. environment and land use committee published its "Guidelines for Benefit-Cost Analysis." It appears to be strictly a system for estimating economic values. But on closer inspection it is evident that the full range of community concerns must be taken into account before any new developments are given the green light.

A case study of a hypothetical character is included in which a new mine is to be opened in a remote area. Following the detailed economic analysis, there are exhaustive studies of fish and wildlife habitats, of potential loss of timber, and of the many social conditions to be addressed in the development of the townsite.

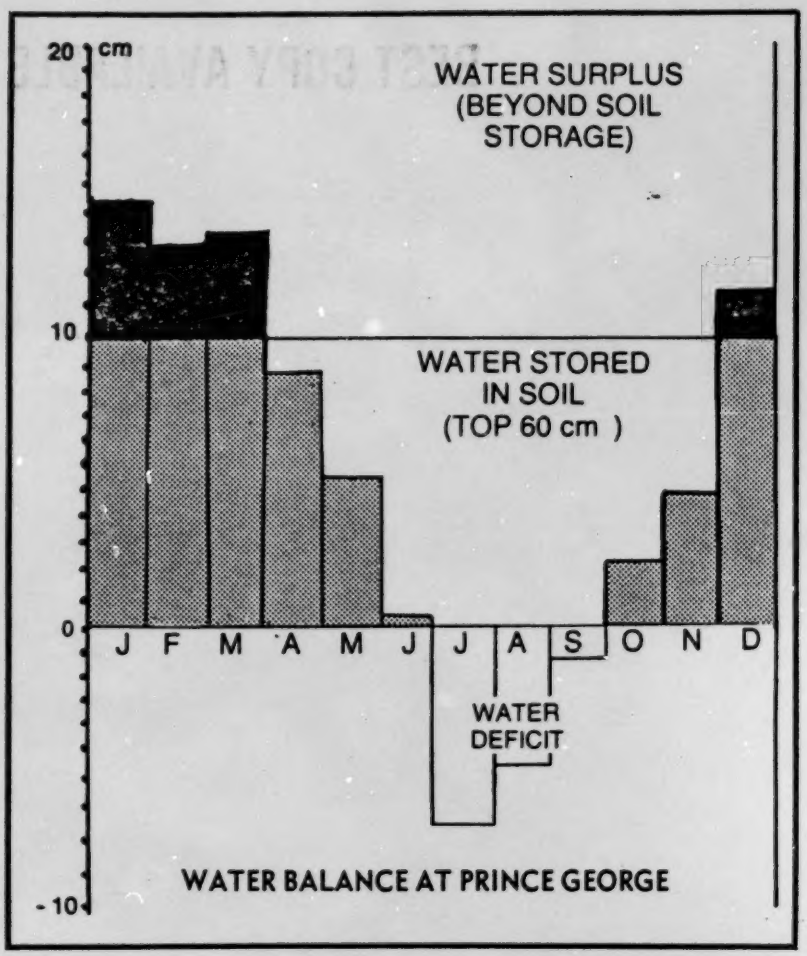
Of particular interest is the fact that these criteria are similar to those established by the Organization for Economic Co-operation and Development in Paris and the Water Resources Council of the U.S.

The goals of the latter are: (i) to promote economic development; (ii) to enhance the quality of the environment; (iii) to enhance social well-being; (iv) to enhance regional economic development.

Water, more than any other resource, stands to gain from this maturing of the shared-use concept. Instead of serving the interests of one or two small groups, the social good of this most valuable resource can be maximized for all.

Questions

1. Why does B.C. have such a high proportion of surface runoff water compared with the rest of Canada?
2. In which areas of B.C. would you expect to find the greatest amount of vegetation protection against flooding?
3. Since we have such a big water surplus in B.C., should we sell some to the U.S. to help us out in times of economic difficulty? Write and tell us what you think. The address: Topic Today, c/o *The Province*, 2250 Granville St., Vancouver, B.C. V6H 3G2.


20 cm
10
0
- 10
WATER SURPLUS (BEYOND SOIL STORAGE)
WATER STORED IN SOIL (TOP 60 cm)
J F M A M J J A S O N D
WATER DEFICIT
WATER BALANCE AT PRINCE GEORGE

Keeping a watch on water balance

WATER balance is the difference between water input and water loss at any given place; it's like a bank balance, what is left in your account.

If there is more input than loss, the excess will be stored in the soil; if the excess is more than the equivalent of 10 cm of rain, there will be a runoff into streams and rivers. Some of the runoff will trickle down into the ground below the soil zone and find its way through rocks and sediment into surface streams at lower levels.

The loss of water is caused by evapotranspiration, a word that means evaporation plus the transpiration caused by plants as they release water vapor back into the atmosphere.

These losses, as the Prince George graph shows, are greatest in summer. If the loss is very severe, as in July and August, then there must be lawn sprinkling and farm irrigation to keep plants from dying.

In wintertime the soil is fully saturated; consequently the danger of flooding from sudden rainstorms is greatest since there is no soil "reservoir" to retain some of the rain.

There are other kinds of flood risks such as when snow melt causes rivers to overflow their banks.

Forests and other forms of heavy vegetation are good protections against flooding from rainstorms as they act like the soil in summer, absorbing some of the rain that would otherwise add to the surface runoff.

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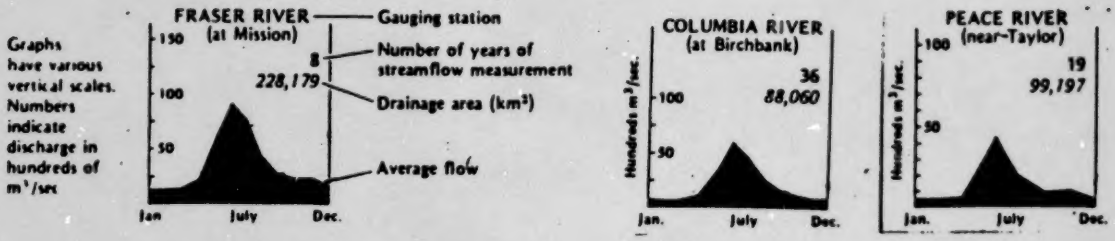
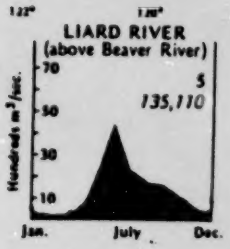




British Columbia's Major Rivers

River	Mean Annual Discharge (m^3/sec)
Fraser	3 600
Columbia*	2 800
Peace*	1 400
Liard*	1 300
Skeena	1 000
Stikine*	1 000
Nass*	900
Taku*	250

*B.C. portion only

1. Which of British Columbia's four major rivers has the highest summer flow of water.
2. Give a reason for the higher flows in summer in all four of these rivers.
3. Estimate the maximum/minimum flow ratios for all four rivers. Why is this ratio important for people who live in flood-prone areas? (Remember that precipitation and temperature shifts frequently take place and these shifts would affect river flows).
4. The Peace River has one of the smallest flows, yet it is the site of British Columbia's biggest hydroelectric power stations. Would it not have been better to use a river with a bigger flow?
5. Is there evidence that the size of the drainage area is a major cause of the size of the summer flow? What other factors might explain the different flows?
6. What problems of shared usage are implicit in the trans-border locations of six of these rivers?

THE WATER CYCLE

Have you ever noticed during a summer shower how rain water disappears quickly into a dry soil? Rain water, pulled by the force of gravity, will tend to trickle downward into the soil along passageways between individual soil particles. Water in the first raindrops to fall to the ground, however, is attracted to and held by the soil particles right at the surface of the ground. As more rain water continues to fall, it enters the ground along the passage ways, descending only until it reaches drier soil particles which can attract and hold it. Thus, during a rain storm, the dry soil particles attract and hold the water in a process that starts first at the surface of the ground and then extends downward into the deeper layers of the soil as the rain continues. In this manner, water falling as rain percolates downward into the ground to become soil moisture.

During a heavy rain the passageways leading downward through the soil may not be capable of handling all of the water falling to the ground. Whenever this happens, the excess water will be forced to flow off, at least for some distance, as surface run-off. Some of this surface run-off may enter a brook or river before it is absorbed into the ground at some distance from its place of origin. Surface run-off is also more likely to occur in those areas where soils have narrow passageways, such as with clay soils, than where soils have broader passageways, such as with sandy soils.

A soil particle in contact with a molecule of water exerts a very strong attractive force between them. This force is stronger then the force of gravity. Soil particles always have a film of water molecules plastered onto each of their exposed faces. Other water molecules line up in layers behind the layer of water molecules touching the soil particle. But the attractive force between the soil particle and each layer of molecules decreases tha farther away the layers of molecules are from the soil particle.

In the last layer of water molecules, at some slight distance from the soil particle, the force of attraction is just equal to the force of gravity pulling the molecules downward. If another layer of molecules were added, the force of attraction would be less than the force of gravity, so it would fall. But the molecules closer to the soil particle, where the attraction is greater then the force of gravity, are held in place and they cannot fall through the soil openings. These films of water around each soil particle may be a little more then five one-hundredths of a centimetre thick. All the films together make up soil moisture. All soil moisture remains where it is until it is removed by evaporation or transpiration.

How much water can be held in the soil as soil moisture? This depends on the soil, and particularily on the average size of the soil particles. For example, in sandy soils, although the individual particles may be large, there are fewer particles and less particle surface area to hold the water molecules than there are in a clay soil. If all soils are averaged, however, they appear to be able to hold about the equivalent of 10 cm of water. This means that the rain water necessary to provide all the water which could be held in the films of water around every soil particle would fill a rain gauge or pan to a depth of 10 cm. This average value of 10 cm is discussed in the study of water balance. (see page 3)

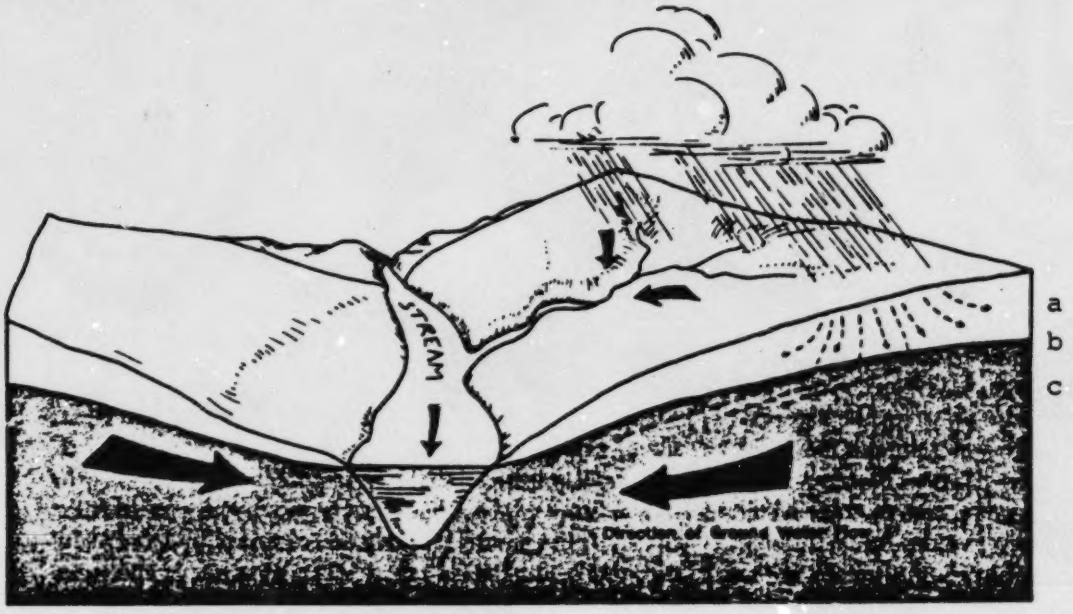
During the warmer months of the year when the amount of energy received at the surface of the earth from the sun is high, soil moisture is lost rapidly from the soil. Heat resulting from the sun's radiation causes water molecules around each soil particle to vibrate more rapidly. As a result, some of these molecules fly off from the films of water in the process of evaporation. But throughout the soil moisture zone, water molecules from these films also pass into the roots of plants. This water then rises through the plants and finally changes back to water vapor through the thousands of small openings on the undersides of the leaves. This process of transpiration, like evaporation, depends on energy from the sun. In summer, therefore, unless the soil mixture zone receives new supplies of rain water, it will dry out to the point where very little moisture is left in the soil. This loss of soil moisture which you have already encountered as evapotranspiration, occurs as a result of the "demand" for soil moisture by the atmosphere. The higher the temperature at the surface of the earth, the greater the demend. Eventually, if demand continues to exceed supply, the soil will lose practically all its stored moisture. From a practical standpoint no more soil moisture remains. But when precipitation supplies more water to the soil than is lost by evapotranspiration, soil moisture recharge occurs.

If supply continues to exceed loss to the point where no more water can be held by the soil particles, all the additional water received continues to move downward in the soil through the larger passageways. The water is pulled downward by gravity. It goes as far as it can, but stops when it reaches places along the passageways which are already filled with water. The passageways are pinched off at their lower ends where the rocks become less and less porous, and therefore water collects in them. The passageways in the ground are filled like teacups from the bottom up. It is from this ground water zone, where all the larger passageways in the soil are filled with water, that wells draw their water supply.

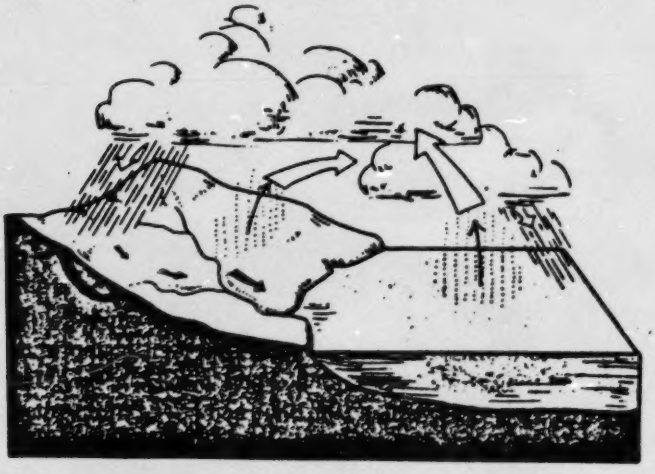
The surplus water which is not needed for soil moisture recharge does not remain, of course, in the deeper layers of the soil. The reason for this is that the surplus water under-

ground is higher than the level of the water in nearby streams and rivers. The surplus water underground therefore continues to move slowly through underground passageways, no longer straight downward but now both sideways and downward toward the streams as shown in the diagram below.

Eventually, at the streams, the surplus water re-appears and flows off toward the ocean as surface water. Surplus water which descends through the soil is therefore the most important part of run-off and the most important element in the flow of rivers.



SKETCH OF THE WATER CYCLE



a] Unsaturated soil

b] Fluctuating Ground Water Table (below which soil is saturated)

c] Permanent Ground Water Storage

PROGRAMMED EXERCISE ON THE WATER CYCLE

The following is a series of 50 items about the water cycle. The items are planned in sequence so that you will learn the water cycle step by step. It is important that you read through and work each item in order, since almost every one gives information about the next.

Start with item one. Read it, then answer item two. Then turn to item three. In parentheses next to item three is the answer for item two. Check this against your own answer.

When you have answered all the items in the programmed learning sequence, check by working the puzzle at the end.

1. Water is continually moving back and forth between the oceans and the land. This movement from the oceans to the land is called the water cycle.

2. The water cycle is the movement of water back and forth between the _____ and the _____.

(oceans; land)

3. Moisture moves from the oceans to the land by being lifted as vapor from the ocean's surface and carried by the atmosphere, over the land where it may be released. Water moves from the land back to the oceans in several ways which you will study later in this program.

4. Water is carried from the oceans to the land by the _____.

(atmosphere)

5. The water cycle can be compared to the way money flows in and out of a business. When a businessman receives money, it is called income, and it is either spent or saved.

6. Likwise, the moisture that the land receives can be thought of as its moisture _____.

(income)

7. This moisture income is received in the from of precipitation which falls to the earth through the atmosphere. Just as the businessman may receive his income in many forms, such as checks, cash, and so on, the land receives its moisture income, or _____ in several forms.

(precipitation)

8. Name some of these forms of precipitation:

1. _____ 3. _____

2. _____ 4. _____

(rain; snow; sleet, hail)

9. The most common forms of precipitation are rain and snow. These are the land's main sources of fresh water. Thus, rain and snow supply the greatest part of the land's moisture _____.

(income)

10. Quite often money income is not steady. It may vary in both the rate and in the frequency it is received. For example, you may receive a lot of money one month and very little the next. This is a variation in rate -- that is, how much you receive at one time. The frequency at which you receive income may also vary. One month you may receive money every week and another twice during the whole month.

11. Precipitation -- the land's moisture income -- may also vary in rate and frequency. Which of the following is an example of variation in rate of precipitation and which is an example of variation in frequency of precipitation?

a] As much as 30 cm of rain may fall in a single hour, or only a few mm in an all-day drizzle.

b] It may rain every day of the week or it may rain only one day a week.

(a] rate; b] frequency)

12. In summary, the land's moisture income consists of _____ which falls to the earth through the _____. The amount and timing of this moisture which the land receives (are/are not) _____ always the same for any given place.

(precipitation; atmosphere; are not)

13. What happens to the moisture once it has reached the land? We mentioned before that the income received by a businessman may be spent or saved. If the moisture income of the land is like the money income of a businessman, then it may also be _____ or _____.

(spent; saved)

14. Some of the water that reaches the land is "saved" for a time. It is delayed in its return journey to the oceans by being frozen into glaciers or ice sheets such as are found in Greenland or Antarctica. This type of "saving" might be

compared to money which a businessman might put away into a special savings account and leave untouched for long periods of time.

15. What is one way fresh water is delayed in its return to the oceans?

(frozen in ice sheets or glaciers)

16. Some of the moisture which reaches the land areas of the earth is "spent" immediately in the form of surface run-off. This moisture never sinks into the ground at all, but runs over the surface of the ground directly into rivers and streams, which carry much of it to the oceans.

17. One way the moisture income of the land is spent immediately is by _____ _____.

(surface run-off)

18. A third alternative for the moisture once it reaches the surface of the land is for it to soak into the ground, where it may be held, or "saved", a while before it is "spent", or returned to the oceans.

19. Once it soaks into the ground, this moisture may take one of two routes in its return to the oceans. It may sink deep into the ground and eventually find its way back to rivers and streams as underground run-off, or it may be returned directly from the upper layers of the soil or through plants into the atmosphere which will then transport it back to the oceans.

20. Once moisture has soaked into the ground, it may eventually find its way back to the oceans in one of two ways;

a] _____ b] _____

(a] seepage through the ground and out through springs into rivers or streams. b] return directly to atmosphere from the soil or through plants.)

21. The movement of moisture through the ground and into rivers and streams is called underground run-off. The moisture seeps very gradually through the deeper layers of the ground until it reaches a stream of river, which then carries it toward the oceans. From there it is evaporated into the atmosphere.

22. Moisture which gradually moves through the soil to rivers and streams is called _____.

(underground run off)

23. As you have seen, some of the moisture that soaks into the ground is not carried away as underground run-off. Instead

it remains in the soil for a while clinging to soil particles. This moisture is on what is called "soil storage". It is eventually removed from the soil in one of two ways. It may be returned to the atmosphere by direct evaporation from the soil, or it may return to the atmosphere by passing through plants.

24. Some of the moisture which soaks into the ground is held in the soil as soil _____. This moisture may eventually be returned to the atmosphere by direct _____ or by passing _____ _____.

(storage; evaporation; through plants)

25. What three things may happen to a raindrop that falls on the land?

a] _____ b] _____ c] _____

(a] movement directly by evaporation or through plants into atmosphere. b] surface run-off. c] underground run-off.)

26. Moisture may return directly to the atmosphere by evaporation. Moisture may also pass through plants and into the atmosphere by a process called transpiration. About 64 per cent of the precipitation which reaches the land is returned to the atmosphere through these two processes. The atmosphere then carries this moisture as water vapor back to the oceans.

27. The amount of moisture which is returned to the atmosphere by the processes of evaporation and transpiration is about what fraction of the total precipitation which falls to the land?

a] one half
b] one third
c] two thirds
d] three fourths

(c] two thirds)

28. Evaporation is the process by which moisture is moved directly from the soil into the atmosphere. Therefore, transpiration must be the process by which moisture returns to the atmosphere through _____.

(plants)

29. Transpiration is the process in which moisture in the ground moves into a plant's roots, is carried up to its leaves, and is then released as vapor into the atmosphere through pores in the leaves.

30. Sometimes a single word, evapotranspiration, is used to refer to the combined processes of _____ of moisture directly from the soil and _____of moisture through plants.

(evaporation; transpiration)

31. _____ is the term used to describe the two processes by which moisture returns from the land to the atmosphere.

(evapotranspiration)

32. Evapotranspiration does not always take place at the same rate. Large amounts of moisture may be removed from the soil through evapotransporation at certain times; at other times, very little evapotranspiration may take place. A most important factor affecting the rate of evapotranspiration is the amount of energy in the form of heat which is present.

33. When soil and air temperatures are higher, as in the daytime, water molecules move at a faster rate and greater evapotranspiration will take place than at night. Would you, then, expect greater evapotranspiration in summer or winter?

(summer)

34. The rate of evaporation is affected by energy in the form of _____.

(heat)

35. If the factor of energy in the form of heat affects the rate at which moisture is evapotranspired, would the rate of evapotranspiration be the same for all times and all places? (Yes or No)

(No)

36. The amount of heat present varies in different parts of the world and at different times. Therefore, the rate of _____ varies at different times and places.

(evapotranspiration)

37. In addition, the amount of moisture available to be evapotranspired may vary. During any interval of time, such as a month, the amount of moisture available for evapotranspiration includes that which is already stored in the soil plus any additional moisture income which may be supplied as a result of precipitation.

38. The moisture available to be evapotranspired during any month includes _____ and _____.

(moisture already in soil storage; additional moisture income supplied to the soil by precipitation)

39. If evapotranspiration exceeds the income or supply from

precipitation for any length of time, the total amount of moisture held in soil storage can be depleted. New moisture coming in will not be able to replace fully all the moisture taken from the soil by evapotranspiration. Thus, the total amount of moisture in soil storage will decrease. Eventually almost all the moisture in the soil may be removed in this way.

40. Of course, it is not possible to evapotranspirate more moisture than there is available. At times, energy conditions may be capable of evapotranspirating much more moisture than is available is soil storage and on the surface of the ground. This condition is known as a water deficit. Once all the moisture in storage has been removed, no more can be evapotranspirated unless new moisture is supplied.

41. A water _____ (deficit/surplus) occurs when the amount of energy available in the form of heat is capable of evapotranspirating more moisture than is actually present in the soil and on the surface of the ground.

(deficit)

42. The energy in the form of heat which is capable of evotranspirating water can be thought of as s sort of "demand" for water. It has been seen that this demand can be expected to be much greater during the warm summer months than during the cool or cold winter months.

43. A water deficit is the condition in which the _____ (supply/demand) for moisture is greater then the amount of moisture available.

(demand)

44. It is also possible to have a water surplus. This is the condition in which the soil if already storing all the moisture that it can hold and more moisture is being supplied by precipitation than can be removed by evapotranspiration. The surplus water will begin to return to the oceans either via surface or underground run-off. A flood may result from an extreme water surplus.

45. Which of the following is an example of a water deficit and which is an example of a water surplus?

a] In the Amazon River valley in South America, the amount of precipitation is much greater than can be stored in the soil and removed by evapotranspiration.

b] In Saudi Arabia the demands of evapotranspiration on soil moisture are much greater than the moisture supplied to the soil by precipitation.

(a] surplus. b] deficit)

46. Water deficits and surpluses may vary from place to place, as you saw in the previous item. They may also vary in one place according to the season, since there are seasonal changes in both precipitation and the energy to produce evapotranspiration. Surpluses and deficits may also vary in one place from year to year.

47. Take for an example an imaginary place. The evapotranspiration rate is very low there in winter, but precipitation is high. Thus, you might guess that the place probably has a _____ in the winter. Conditions are just the reverse in the summer. It is very hot so the evapotranspiration rate is extremely high. At the same time there is almost no precipitation during the summer. Thus, Evapoland probably has a _____ in the summer.

(water surplus; water deficit)

48. Can you figure out why it is important to understand the water cycle and water surpluses and deficits? How does it help man to know about such things?

49. Knowing about the water cycle and surpluses and deficits can help us to predice the "when" and "where" of the supply of water. Man needs water for himself, his animals, his crops, and his industries. He needs to know where and when water will be available so he can decide where to locate homes, farms, and businesses; so he can know what to grow; and so he can know whether or not to supplement his natural water supply, by how much, and when.

50. Now that you have finished, go on to the puzzle.

FINDING OUT

1.

The average daily water use in B.C. in 1930 and in 1980 was as follows. Figures are in millions of litres per day.

Year	Municipal	Agricultural	Industrial
1930	1	0	1
1980	4000	250	300

-What trend is evident from these figures?

-Which type of activity used most water in 1930? In 1980?

-Which category increased its demand the most between 1930 and 1980? Where, therefore, is the problem of water pollution likely to be the greatest?

2.

Find the cities in B.C. that have a water shortage every summer and those that have a surplus throughout the year.

REVIEW PUZZLE

Match the number at the left with the letters on the right. Each number may be used only once.

When you have completed the matching, transfer the numbers you have matched to the lettered boxes in the puzzle. If you have matched correctly, the sum of numbers in any row will equal the sum of the numbers in any other row. For instance, the sum of the numbers in squares A, B, C, and D will equal the sum of the numbers in squares B, F, K and P. The sum of the numbers for the diagonals (A, F, L, R and D, G, K, N) will also equal the sum of the numbers for any row.

Answers	Clues
1. low temperature	a. Moisture held in top layers of soil.
2. transpiration	b. The process by which moisture is removed from the ground and plants and returned to the atmosphere.
3. water cycle	c. A factor which causes the demand for moisture to be greater.
4. evaporation	d. The total amount of moisture which the land receives.
5. evapotranspiration	e. Where evapotranspired moisture goes.
6. high temperature	f. Term for describing how much precipitation occurs within a given time.
7. atmosphere	g. Condition in which all moisture has been removed from soil storage and the demands of evapotranspiration are not met.
8, demand	h. Process by which water returns as vapor directly to the atmosphere from the ground.
9. water surplus	i. Process by which the land receives its most important source of fresh water.
10. rate	j. Another term for the evapotranspiration rate.
11. moisture income	k. The movement of moisture back and forth between the oceans and the land.
12. underground run-off	l. Moisture that cannot be absorbed by the ground and therefore moves over the top of the ground to rivers and streams.
13. precipitation	m. Process in which moisture is returned to the atmosphere through plants.

14. supply

15. surface run-off

16. two thirds

17. soil storage

18. water deficit

19. frequency

20. one third

n. The approximate fraction of the land's total moisture income that returns to the atmosphere by evapotranspiration.

o. The seepage of mositure through the top layers of soil to the lower layers, and to rivers and streams.

p. Condition in which the amount of moisture supply is greater than the evapotranspiration rate and the soil is filled to its storage capacity.

REVIEW PUZZLE

a	b	c	d
e	f	g	h
i	j	k	l
m	n	o	p

WATER BALANCE GRAPHS

The calculations needed to draw water balance bar graphs like the one on page five, when given PE (Potential Evapotranspiration) and P (Precipitation), are done in the following way:

1. Begin with the month of January and assume that there are 10 cm of precipitation in the soil.

2. Add the amount by which precipitation exceeds potential evapotranspiration for January and mark the final total on graph.

3. Repeat for February, again beginning with 10 cm of precipitation in the soil, since all the January moisture in excess of that has disappeared as run-off.

4. When you come to a month in thich PE is greater than P the final graph total will drop below the 10 cm level by the amount of the difference PE - P. Sometimes, as in the case of the Prince George graph, the final figure drops below the zero level, showing that the soil requires irrigation if plants are to grow.

5. Continue plotting graph values month by month up to December.

6. Draw bar graphs for Cranbrook, Kamloops, Nelson, Penticton, Prince Rupert and Vancouver using the data on the next page.

WATER BALANCE DATA FOR SELECTED CITIES OF BRITISH COLUMBIA

Potential Evapotranspiration (PE) and Precipitation (P) are recorded in millimetres

	Cranbrook		Kamloops		Nelson		Penticton		Prince Rupert		Vancouver	
	PE	P	PE	P	PE	P	PE	P	PE	P	PE	P
JAN	0	46	0	26	0	88	0	25	7	248	6	218
FEB	0	30	0	19	0	58	0	19	11	192	13	147
MAR	0	22	13	10	11	50	19	17	23	214	27	128
APR	40	17	52	10	45	40	47	17	45	169	48	85
MAY	76	30	90	22	82	52	84	27	67	135	77	72
JUN	103	44	118	33	106	64	113	31	87	103	103	62
JUL	123	29	142	25	130	41	135	20	100	121	119	31
AUG	106	23	123	27	112	37	117	21	96	131	104	43
SEP	64	28	72	21	70	44	74	25	71	196	70	92
OCT	29	23	37	17	33	60	38	21	44	310	44	147
NOV	0	33	6	22	6	79	10	24	25	311	21	210
DEC	0	42	0	27	0	92	0	29	10	287	11	222
YEAR	541	367	653	259	595	705	637	276	586	2417	643	1457

Power politics and hindsight

HINDSIGHT HAS BECOME a popular word in recent years when it came to reviewing the Columbia River Treaty. The media has been assessing the environmental aspects of the work that was done in the sixties. Politicians have vied for space in the press to challenge or support the decision to sell the downstream benefits.

Environmental concerns focussed on the disruption that hit the natural habitats and the various small communities. Places that had been picturesque and turn-of-the-century hamlets were suddenly catapulted into the rough and tumble world of dam construction, house removal, land inundation, road re-routing, plus a large influx of construction workers.

Sometimes the process of relocation and compensation was handled badly. The bureaucracy was big and there was a strong sense of urgency since any delay in completing the work would have cost dearly.

Whenever local residents sought redress in the courts they met with strong opposition. In many cases justice did not appear to be done.

The scale of operations at the dam sites can best be gauged by the enormous amount of relocation and new construction required. At the Arrow, for instance, (now the Hugh Keenleyside Dam) three new communities had to be developed by B.C. Hydro to accommodate the thousands of people displaced — Burton, Edgewood and Fauquier.

In addition, there were roads, railways, schools, hospitals, park sites, airports and recreational facilities, all of which had to be designed, planned, funded and constructed.

The political battles, both at the time of the treaty and in the continuing debate, were frequently directed at the economics of the project.

At the beginning, when the Premier W.A.C. Bennett was about to sign the B.C. portion of the treaty, he did two things: took over the B.C. Electric Company and set up the B.C. Hydro and Power Authority, and launched the two-river policy — the simultaneous development of both the Peace and the Columbia Rivers.

By
ANGUS GUNN

Reaction was swift. Opposition politicians dubbed a two-river policy economic madness. World bankers threatened to interfere with the province's borrowing powers because it had interfered with a large private enterprise and did not give adequate compensation. The political and economic turmoil came close to a breakdown in the institutions of government.

This was how Bennett recalled these events in 1976, three years after the third and final Columbia Treaty dam had been built:

"That was the thing in all of my political life of which I am the proudest. By going ahead on the Peace we were able to force the U.S. to give us a better deal than ever would have been possible on the basis of the Columbia alone. Furthermore, by selling our downstream power benefits for 30 years, we have ensured an income at the end of that time that will more than pay for all the Canadian power developed on the Canadian side both past and present."

The prediction concerning the value of the downstream benefits gains in accuracy with the accelerated growth in energy costs. Assuming 10-per-cent annual inflation, the replacement value for Canada, at the conclusion of the 30-year period, will exceed $300 million annually.

The big problem with hindsight is that it is rarely accompanied with an understanding of the social world of the past. We look at events and assess them as if they were just happening.

Often the result is a belittling of the values of the past in the same way as some future generation is likely to do with ours.

Dams Down Under

EARLY in 1982 the following story appeared in several Australian newspapers: Tasmanians have voted in favor of a controversial hydro-electric plan to dam the Franklin River, destroying an area of outstanding natural beauty.

The referendum issue has split the ruling socialist government, forcing the resignation of the former leader and putting Tasmania's socialist party in conflict with the federal conservative party which opposes the flooding of the Franklin; recently the federal authorities nominated the Franklin region for the world heritage list.

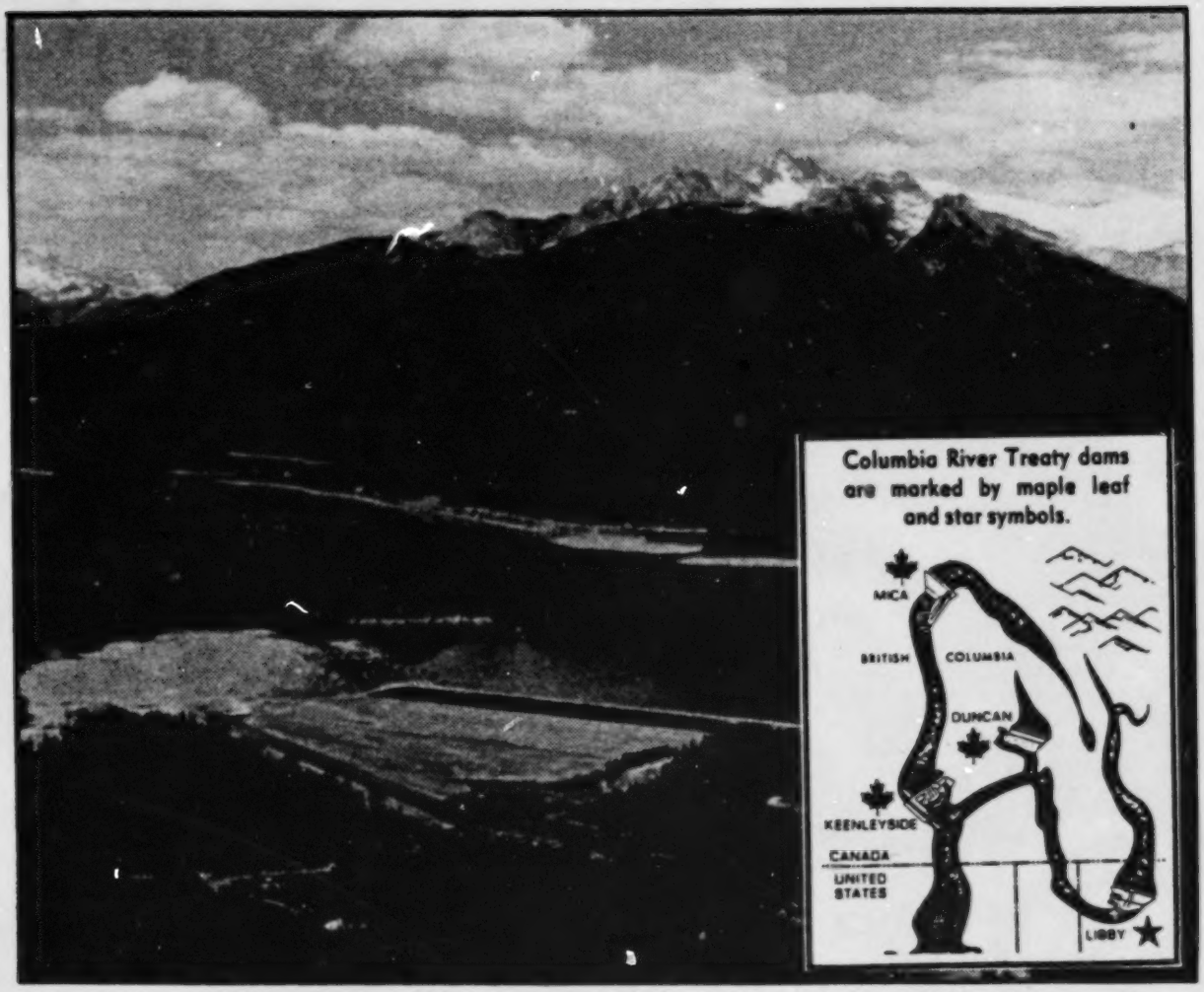
Sir Edmund Hillary has called the Franklin "one of the last great wilderness areas in the world;" the British botanist, Dr. David Bellamy, said that to destroy the area would be "an act of international vandalism."

In support of the dam project it has been pointed out that the area is quite inaccessible, with very high rainfall — 300 cm a year (118 inches).

One Tasmanian has put it this way: "In the present condition of the world, with oil costly and supplies dwindling, with the burning of coal causing serious pollution, and with the widespread fear of nuclear power plants, any country blessed with non-polluting, self-renewing water power resources commits a crime against humanity in not utilising them to the full."

Questions

1. What are downstream benefits?
2. What causes the annual flooding in the Columbia River Basin? Why is it more serious here than in some other North American rivers? In what ways do dams protect communities from floods?
3. How should problems (like the Tasmanian one) over conflicting uses of water resources be resolved?



Duncan Dam — First of the Columbia Treaty dams to be completed.

The early sixties were times of great optimism. Growth generally and development of natural resources were axioms. There was a euphoric attitude toward new industries, new mines, new roads; the costs in terms of disruption of the environment — a word that was almost unknown at the time — or discomfort of a few people, were seen to be small in comparison with the greater benefits for all, as economic development went ahead.

Historians grapple with the problem of context in all of their work; so they are aware of this factor. Politicians are not, or will not. After all, they are dealing with voters who see things in the present for the most part. The problem persists.

Who, for example, has given much thought to the fears of those who, every year, wondered if a Columbia River flood was going to wipe out their hard-earned gains? The horrors of the 1948 flood, in which 41 people were lost and 38,000 made homeless, are not readily forgotten by those who were there at the time. To such, the Columbia dams spell safety, money in the bank.

These floods were annual threats. The ratio of lowest water levels to highest, at the point where the Columbia crosses the U.S. border, is 1:53, one of the highest on the continent. A rapid snow melt season in the mountains or an unusually high rainfall could cause more damage than all the dislocations of the treaty dams.

Behind the debate over downstream benefits there is a less obvious yet vital principle: should a society only be concerned about its own needs or should it also make provisions for its grandchildren?

There is a political philosophy which says yes to the latter and there is one which says, in effect, borrow all you need for the good life now and let another generation look after the debt.

In relation to the Columbia one view goes something like this: let's renegotiate the treaty and get back the downstream benefits now so we will not have to build so many new dams for the power we presently need; it is not a very realistic option, say the experts, because it simply cannot be done.

The other view says: let's provide for our present needs through new developments and let us leave a heritage — the power or the money value of the downstream benefits — for those who will come after us, who must face a much tougher environment than the one which confronts us now.

The choice is not an easy one for a society that is beset with economic stress. It is like saying to someone who badly needs to remortgage his home in order to stay out of the red: don't do that; pay off the mortgage so that your children, maybe your grandchildren, can get a head start in life by having a mortgage-free home.

A sensitive issue

Should we sell our water?

By ANGUS GUNN

THE DANGER of an overall shortage of water in Canada is remote; the country's population and industrial development could multiply many times before there would be any concern over water availability; so why not sell or share some of our present surplus? There are plenty of takers east and south of us.

It is true that parts of B.C. suffer from severe shortages. The Okanagan Valley will probably hit a crisis before the turn of the century; but these are largely unrelated to the cross border flows of the big rivers.

Take, for example, the Point Roberts problem. This anomaly, a small peninsula isolated from the rest of the U.S., has to get all its imports from Washington State via water or by land through Canada.

The permanent population of this mini-state could be increased 30-fold if only B.C. would sell some of its water to the area.

Politicians of all parties play it safe by outright rejection of any plan to sell water permanently to the U.S. They know it is a sensitive issue.

Not everyone is taking the safe line; Gordon Shrum, who has been involved in so many aspects of B.C's life, takes the view that we should be willing to sell some of the water that flows past our door into the sea.

The worry about sale of water to the U.S. dates from the famous NAWPA (North American Water and Power Alliance) Plan, a gigantic 1965 proposal to divert water from Alaska and B.C. into the parched areas of North America, including Mexico; the proposal included the creation of one continuous lake stretching from Alaska to Mexico.

Even as far back as 1965, costs for this 21st-century wonder were estimated at $150 billion with a 30-year construction time frame. Benefits to Canada included a cross-Canada canal and abundant water for the Prairies.

No one at the time recognized that the whole idea was nothing more than an engineer's dream, an exaggerated proposal designed specifically to stimulate thought on water transfer, never intended to be implemented.

The worry over water sales arose when within a few months of the publication of NAWPA, Canada was launched into a national election and Prime Minster Pearson proposed the sale of water to the U.S. Many people thought that he was advocating NAWPA.

The Columbia River Treaty had just been signed and Canadian concern was heightened when members of the U.S. Senate suggested that existing and proposed dams could form part of any big NAWPA-type scheme.

All of these fears could ordinarily be relegated to history and a completely fresh approach could be taken in the '80s. Unfortunately NAWPA refuses to go away. The fear of pressure from the U.S. for Canada's water is greater than ever.

Soon after President Reagan took office in 1980, Ralph Parsons Engineering — the company that proposed the original 1965 plot — surfaced with fresh ideas about their plan; a few months later, *Scientific American* presented a detailed account of NAWPA.

On the Canadian side, the demand for B.C.'s water comes from Alberta or rather there is demand for the water that flows eastward and northward in the Peace.

Sixty per cent of the flow of Canada's rivers drain to the north while 90 per cent of the population is concentrated along the U.S.-Canada border. Most of the industry is also concentrated in the south.

Alberta has a double need for more water: first, irrigation for the dry lands in the southern half of the province; second, water for the rapidly expanding energy and petrochemical industries.

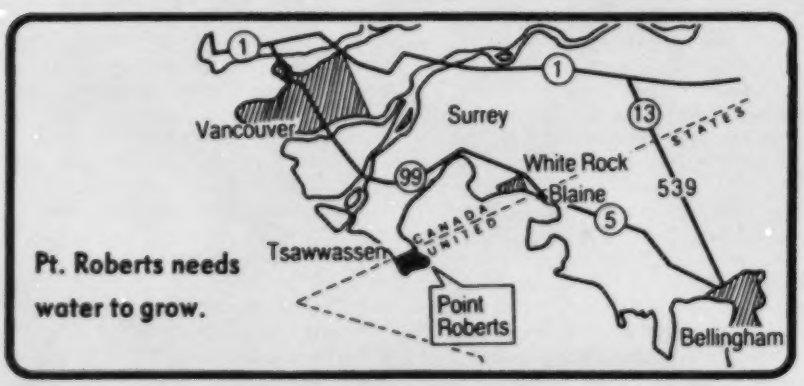
One of the strongest arguments against both the diversion of the Peace southward and the sale of water to the U.S. comes from an MP for the Northwest Territories.

He points out that major — perhaps irreversible — changes would occur in the delicate ecology of the Arctic; furthermore the salinity of the northern ocean water might be significantly changed, thus affecting the amount and timing of sea water freezing; in turn this would have its effect on weather all across the continent.

Water transfers that span provinces and countries soon become permanent transfers. Unlike other resources, water affects life in so many ways that it would be virtually impossible to cancel an arrangement that had been in place for, say, 10 years.

But, as we have already discovered in other water uses, the values and interests of a society change over time. New stresses are created. Relations between the two administrations that share the water have worsened.

The Bennett Dam on the Peace was hailed at the time as a boon to residents in the Peace-Athabasca delta who lived under the threat of floods; today, people are asking if it might have been better to allow the risk of flooding in order to preserve the annual cycle of high and low water and thus restore a valuable wetland area.



Questions

1. Explain how a reduction in the amounts of fresh water flowing to the Arctic would change the timing of the freeze-up of ocean water.
2. In Europe several countries have accepted limitations on their sovereignty in the interests of strong relations with their neighbors. Should we be willing to do likewise in relation to water resources in order to be a good neighbor to the U.S.?
3. Could the problem of water for Point Roberts be used by Canada to negotiate a swap of that bit of land for another area of comparable size or value?

Tapping the oceans

MORE THAN 97 per cent of all water on earth is in the oceans. If, then, it becomes technically and economically feasible to use this vast resource by separating the salt from the water, there will be little difficulty in providing all the fresh water needed.

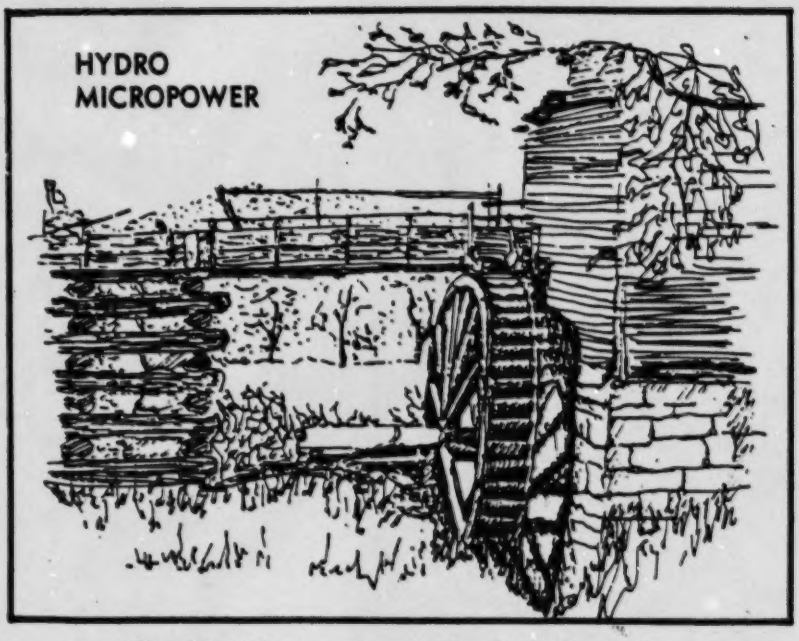
Such a hope is the dream of the people who work in desalination research.

The technology for securing fresh water by this means is well developed. Throughout the world there now are more than 1,000 plants in operation; together they produce more than 20 cubic metres (26 cubic yds.) per second of fresh water, enough to provide for the needs of urban areas, each the size of Metropolitan Vancouver.

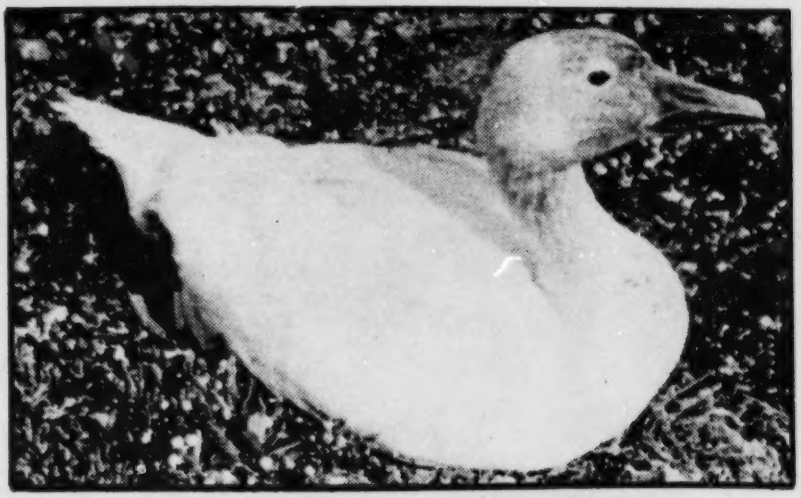
Hong Kong and several Middle East countries are in the forefront of these desalination projects. They are the countries that have the greatest needs because of the small quantities of water available to them from normal weather cycles.

Nuclear power stations are being studied for use in desalination plants; they are the cheapest forms of installation provided they operate on a reasonably large scale.

In spite of all the fears accompanying the use of nuclear power for energy, many of the world's big cities — including Tokyo, New York, Karachi, Lima and Singapore — are actively looking at this method as a possible source of fresh water.



The old and the new: Above, the waterwheel and the dam were used to generate power in pioneer days; Right, a giant turbine in the Gordon Shrum generating station on the Peace River.



Snow geese from N.W.T. stop at Reifel reserve.

Questions

1. Why are the big urban areas the places most likely to get serious water quality problems?
2. Why is the problem of fresh water so bad in developing countries when they have much fewer water-consuming industries than we have?
3. A few years ago, Saudi Arabia proposed towing icebergs from Antarctica to supplement its fresh water supplies; what do you think about this idea? What precautions should be taken on the voyage from Antarctica if the Saudis did go ahead with it?

FEW WETLAND areas of B.C. can match the attraction of the Reifel bird sanctuary on Westham Island in the south arm of the Fraser River delta.

This marshy island is winter home to birds from central and Arctic Canada, sometimes as many as 100,000 in a single season.

There are some permanent residents — enormous trumpeter swans, whistler swans, white front and snow geese, and hundreds of ducks — and these form the basic attraction for the thousands of people who come to the sanctuary each month.

Reifel sanctuary

How birds successfully migrate thousands of kilometres will always be a mystery. They do not seem to have any navigational aids, yet they arrive at the same tiny spot, year after year, often on the same day. As many as 10,000 snow geese have made the journey to the sanctuary in one season; some came from as far as northern Baffin Island.

Surprises are frequent: Australian black swans insist on arriving to nest on Australian time, that is at Christmas, so they often have to raise their brood amid the snow and ice.

A serious mosquito problem was resolved by building 200 nesting boxes for tree swallows; each swallow eats seven grams (¼ oz.) of mosquitoes each day.

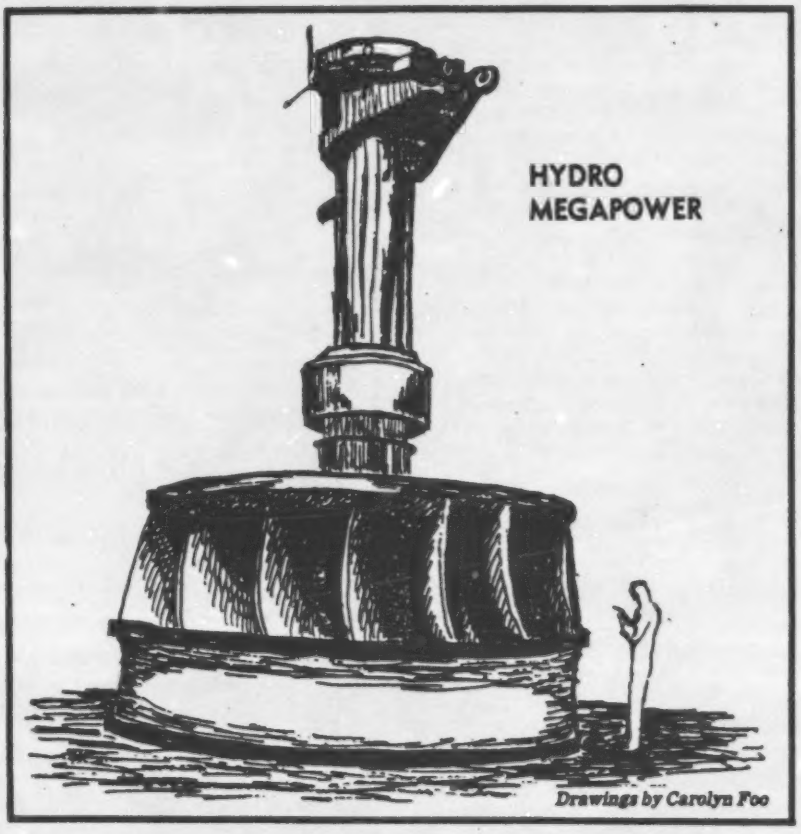
Some years ago a rare first was recorded: The spotted redshank, a bird that normally winters in southeast Asia or in the Mediterranean, was noticed among some ordinary redshanks and yellowlegs.

This bird's habitat is in the Siberian tundra; this was the first sighting in a decade in North America, and only the fourth ever seen on this continent.

Bird watchers from all parts of North America flocked to Reifel.

Questions

1. Find out what a self-perpetuating ecosystem is.
2. Big glaciers like the Franklin, advance and retreat several kilometres over a period of years. What causes this?
3. Since there is so much water available in the oceans, why cannot Third World countries get all the water they need by desalination? This process, by which fresh water is obtained from salty ocean water is now a well-established method.



Drawings by Carolyn Foo

SLAVES OF SOCIETY

The basic principle of electricity generation is quite simple. A permanent magnet has two poles, north and south. The invisible force which attracts and repels is always present between and around these poles. The unseen lines of force come out of one pole and return to the magnet at the other.

If a good conductor of electricity such as copper moves across these lines of force, an electrical current flows in the conductor.

It does not matter whether it is the magnet or the conductor that moves; as long as there is relative movement, electricity is generated.

In a hydroelectric power station, water is stored in a dam and released in a controlled way through penstocks (pipes that carry the water to a lower level). At the bottom end of the penstocks, turbines are driven by the force of the water. These turbines are connected to shafts which, in turn, are connected to large magnets.

One of the earliest turbines could produce as much electricity as 100 men. That's about 3,000 watts. It represented a small amount of energy in terms of today's rates of consumption.

Today, the average Canadian is served by an army of slaves, electrical ones, that far exceeds the energy expended by the slaves that waited on Alexander or Caesar.

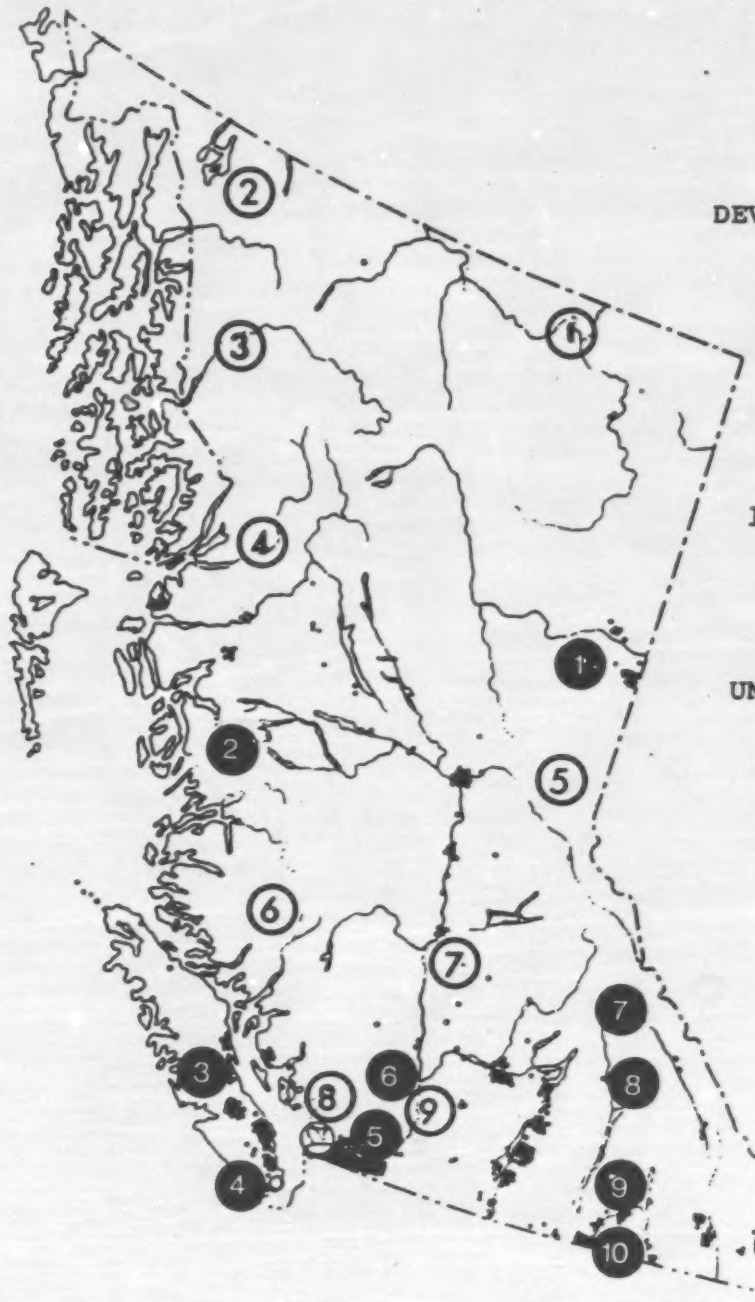
Technology has yet to provide an economic way of storing electricity in the large quantities demanded by today's society.

Questions

1. What is meant by saying that Roman emperors had fewer slaves than we have?
2. Why are people less enthusiastic about big hydroelectric power projects today than they were 20 years ago?
3. What do you think about the idea of large numbers of small hydroelectric generators rather than a few big ones? Which would cause the greater interference with recreation and scenery? Tell us what you think. Write to: Topic Today, c/o *The Province*, 2250 Granville St., Vancouver, B.C., V6H 3G2.

MAJOR HYDROELECTRIC SITES (over 250 megawatts)

The small black dots indicate population distribution, the large black circles developed sites, the large white circles the undeveloped sites.



DEVELOPED SITES

1. Peace
2. Kemano
3. Campbell River
4. Victoria
5. Lower Mainland
6. Bridge River
7. Mica
8. Revelstoke
9. Arrow Lakes
10. West Kootenay

UNDEVELOPED SITES

1. Liard
2. Yukon-Taku
3. Stikine
4. Skeena
5. McGregor
6. Homathko
7. Middle Fraser
8. Squamish
9. Lower Fraser

The new environment

By ANGUS GUNN

THE NEW environment is slowly taking shape; in the place of the confrontations, the simplistic approaches of the early seventies in which arguments over man's use of his habitat were usually tackled on a "one-use" basis, there is emerging a serious, competent, comprehensive style of analysis.

Concern over quality of environment steadily mounted throughout the seventies. Pollution of urban waters threatened the already crowded cities; flood risk increased as the Lower Fraser Valley anticipated a repeat of the disastrous 1894 and 1948 floods; diminishing wilderness space coincided with widespread increases in interest by masses of people.

The new approach includes more co-operation and thorough research. Last year, for example, a group of 10 environmental agencies, including the Sierra Club, Greenpeace and the Society Promoting Environmental Conservation, formerly known as Scientific and Environmental Control Society (SPEC), organized a conference and launched a series of research projects.

One of these projects focused on energy. Do we really need all the additional electricity that such projects as Site "C" on the Peace River will provide?

The sophisticated answer of today's environmentalists is "No," if you are only thinking of a steadily rising standard of living for the present population plus a modest increase over the next 20 years; and this answer is backed by accurate information.

This claim is supported by experts from an unexpected quarter, B.C. Hydro. Given expected improvements, they say, in design and control in such electrical items of equipment as motors, house and office heaters, lighting and residential water heaters, there could be a saving of as much as the annual output of three Site "C" projects between now and the year 2000.

Conservation of energy allows for increased consumption from present sources so there is no need to anticipate a freezing of existing standards of electrical consumption just because there is a freeze on additional supplies.

But coping with existing needs is not enough when dealing with a subject as complex as energy. There are all the future needs. Where, for example, will Tumbler Ridge's 10,000 people get their electricity; or, for that matter the industrial operations in the Northeast Coal Project which is giving rise to Tumbler Ridge?

What about all the in-migration from other parts of Canada? And where are existing mining operations going to secure the additional electricity needed to exploit lower grade ores?

One of the dreams of river protection environmentalists has long been the local management team. It goes like this: assemble representatives from local interests groups and have all decisions affecting the river handled by this team.

It is an approach that has worked in different ways in the past in different places, usually in densely populated regions in areas of moderate terrain relief.

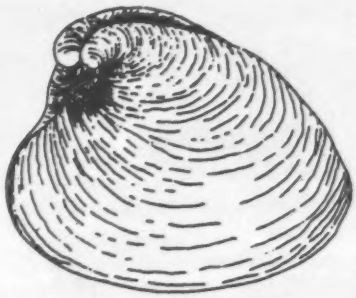
In B.C.'s high relief, thinly populated, largely undeveloped territory this kind of approach is unrealistic. The McGregor Diversion story is a classic example of a river where the concerns of one section of the river, the lower reaches, could not be reconciled with the values of those who live in the upper reaches.

In contrast to the local management team approach there is the "watershed democracy" notion, strongly advocated by some at last year's B.C. alliance of environmental agencies.

In one sense it is a flashback to the days of extremes, perhaps a reflection of the frustration experienced by anyone attempting to circumscribe the dimensions of environmental issues.

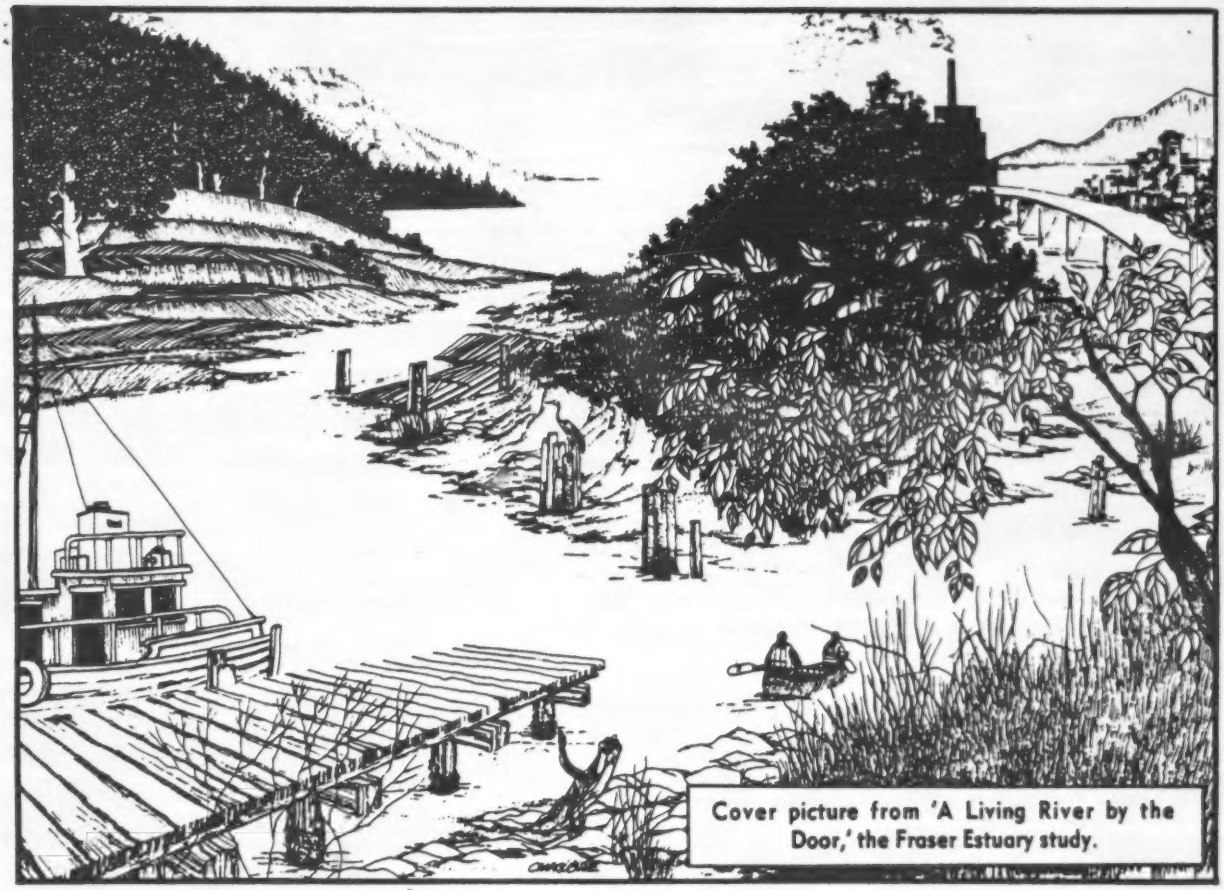
It goes like this: let's make the area west of the Great Divide — the Yukon and most of B.C. — a sovereign state. The concept is based on bioregionalism, something that offers us the only enduring possibility of protecting the environment.

Bioregionalism, or watershed democracy as it has been called, offers the only answer to the eco-



Drawings by Carolyn Foo

About five years ago in the U.S. Northeast, a half-billion dollar hydroelectric project was scrapped because it might have destroyed one of the last remaining collections of a rare fern, the lowly lousewort (left), so called because of an old belief that lice lived on its hairy leaves and stems. The lousewort just happened to be on the U.S. Interior Department's list of endangered species. Another endangered species — the tan riffle shell mussel (top), a fresh water shellfish resembling an ordinary clam — blocked construction of a $142-million Tennessee Valley Authority hydroelectric dam.



Cover picture from 'A Living River by the Door,' the Fraser Estuary study.

logical crisis, claim its exponents.

Whatever ideal may have been contained in the concept of Canada's nationhood, they go on to say, has been betrayed. Power has been seized by a majority more than 3,000 km away. B.C. is a colony again. Our colonial status and our ecological crisis are one and the same thing.

It is perfectly clear that watershed democracy will not get very far. It is also clear that autonomous local management teams will not work in B.C. The Site "C" hearing made that clear. Many local residents were in favor, many were opposed to the scheme.

Planning at the highest levels of government, involving policies on economic, environmental, energy, transportation and settlement aspects, then moving down step by step to specific site-issues will probably remain the pattern of decision-making on water resources for some time to come.

At the same time the consciousness raising and serious research efforts of environmentalists have ensured that never again can there be a major single-purpose water-use project; participatory decision-making of the widest possible scope is the only acceptable pattern.

GOING TO WASTE

THE BIGGEST problem in the new environment is the pollution caused by human activities in the densely populated urban areas; in the Fraser Estuary, scene of a recent federal-provincial study to determine the best ways of caring for the river, more than a million cubic metres of effluent are discharged into the river daily.

Most of this effluent is municipal sewage which, theoretically, is being treated and rendered harmless at the Iona, Lulu Island and Annacis Island plants. However, constant monitoring is essential to prevent the harmful effects of excess flows.

Twenty years ago the oyster industry in Boundary Bay, consisting of 55 per cent of all the province's oyster production, was made unsafe because of a problem of untreated sewage. The Boundary Bay industry has never recovered.

Of even greater difficulty is the disposal of solid wastes. Traditionally, landfill sites have been used to dispose of garbage but sites are increasingly hard to find and existing sites are becoming overloaded.

The preservation of "A Living River by the Door," as the federal-provincial study is named, is going to challenge the goals of the new environmentalists; urban growth is a phenomenon that will be with us for the rest of this century. For B.C. that means greater and greater environmental pressures on the lower reaches of the Fraser.

Questions

1. What is the source of most of the pollutants that are dumped into the Fraser Estuary?
2. How does the new environment differ from the older approaches? What are the problems in the new approach?
3. In France there is a water tax just like the one in B.C. but in addition there is a pollution tax which everyone using rivers has to pay, with added costs for those who cause excessive pollution. The pollution tax money is used to clean up the rivers. What do you think about this system? Would it work in B.C.?

McGregor Diversion dilemma

EVER SINCE THE disastrous Lower Mainland flood of 1948, the McGregor River Diversion has been seen as one of the best and least expensive ways of minimizing the effects of another flood.

By
ANGUS GUNN

Statistically speaking, the likelihood of another flood of even greater proportions than the 1948 one is a certainty, probably before the year 2000.

The McGregor River rises in the Rockies near the source of the Fraser River near the Alberta-B.C. border and it flows in a variety of directions for 150 km before joining the Fraser northeast of Prince George.

One of its tributaries rises in a low divide which is only about 500 metres from a tributary of the Parsnip River which flows northward into the Peace River.

It was this close proximity to the Arctic drainage system that started the thinking about diversion.

The diversion scheme would redirect part of the flow of the McGregor through the Arctic Divide into the Parsnip River by building a dam on the McGregor.

At peak flow times in the early summer, when the snow melt from the Rockies builds up quickly, as much as 40 per cent of the total amount of water in the Fraser River at Prince George comes from the McGregor system.

It is at peak times that the danger of floods in the Lower Mainland is greatest. The possibility of controlling so much of the Fraser's water at these times was obviously appealing to those concerned with flood control.

The electrical power advantage of the McGregor Diversion scheme turned out to be just as impressive as that of flood control.

Since there was a hydroelectric power installation already in place on the Peace River, the additional water coming from the McGregor could be used to increase the output of the existing generators without adding any new generators or transmission lines.

At the time when the diversion project was receiving serious consideration, in the mid-Seventies, the output from Peace River generators was providing a third of all of B.C. Hydro's power. The additional water from the McGregor would have increased that output by 15 per cent.

It was an attractive prospect. Nowhere else in the province could so much additional hydroelectricity be produced so cheaply. Nowhere else could power be obtained with so little damage to the environment, or so it seemed until the fisherman appeared on the scene.

A parasite was discovered in the chinook salmon of the Fraser system, a parasite of the worst kind and one which had never been found in the Peace or its tributaries.

If the McGregor River system, it was said, were linked with the Peace system by a continuous waterway, then this dangerous parasite could get into the fish of the Arctic drainage basin and destroy them.

In reality very few worried over the possibility of infecting the Arctic system; the real interest focused on the rich Fraser harvests.

Fishermen entered the picture at an earlier stage when it was feared that Peace River parasites might destroy the Fraser salmon industry.

By the time that B.C. Hydro had conducted a variety of research studies and had established that the original problem no longer existed, all sorts of actors had become part of the scenario — government representatives from B.C., Alberta, Northwest Territories, federal departments, plus fishing interests from both commercial and sporting lobbies.

Fears had been raised; many questions were being asked as to the adequacy of the research data; requests were being made for a more thorough investigation of the parasite problem throughout the system, including the whole Mackenzie River basin which receives water from the Peace.

In the end, the prospect of additional research and subsequent delays changed the whole character of the project and so B.C. Hydro placed the project on hold.

In many ways this story represents the opposite extreme of pioneer development in which environmental concerns scarcely feature at all; here is an example of a small population of sport fishermen retaining their use of the river at a cost that substantially increases the energy bills paid by more than two million others.

Furthermore, in all probability, the parasite fear might never materialize, as there is ample evidence to suggest that fish transfers take place all the time across the Arctic Divide.

In that case, the freezing of the project is due to nothing more than an imagined environmental risk.

There are other considerations; is it right for one thinly populated section of a province to interfere with the interests of a whole province?

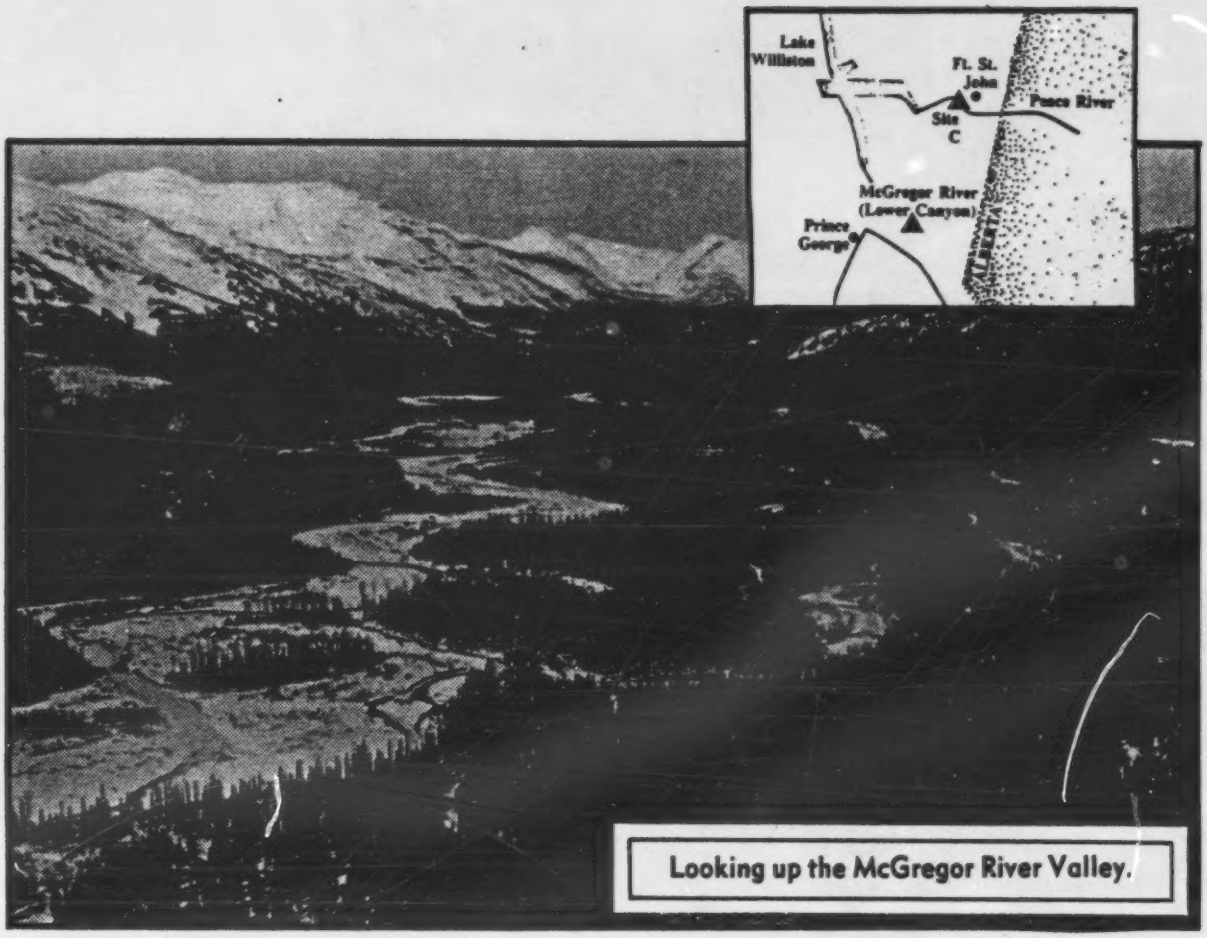
One view states that it is wrong for benefits to accrue to, say the Lower Mainland, when all the costs and no benefits are dumped on the area experiencing the dislocation — as in the case of the McGregor.

One rebuttal is that everyone benefits in a province when the interests of the majority are recognized.

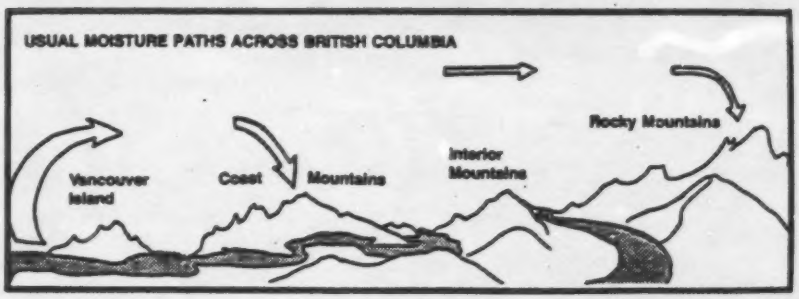
Another conflict of values relates to the relative importance of preserving recreational and wilderness lands when some interference with these environments might save lives and preserve millions of dollars worth of property.

Overall, the McGregor Diversion story is one more step toward a true sharing concept in the use of our water resources.

In place of such polarities as wilderness versus power, fish versus flood control, no growth versus acceptable rates of economic growth, local autonomy versus provincial responsibilities, there is a growing recognition that all of these interests have a place in decisions over the use of water.



Looking up the McGregor River Valley.



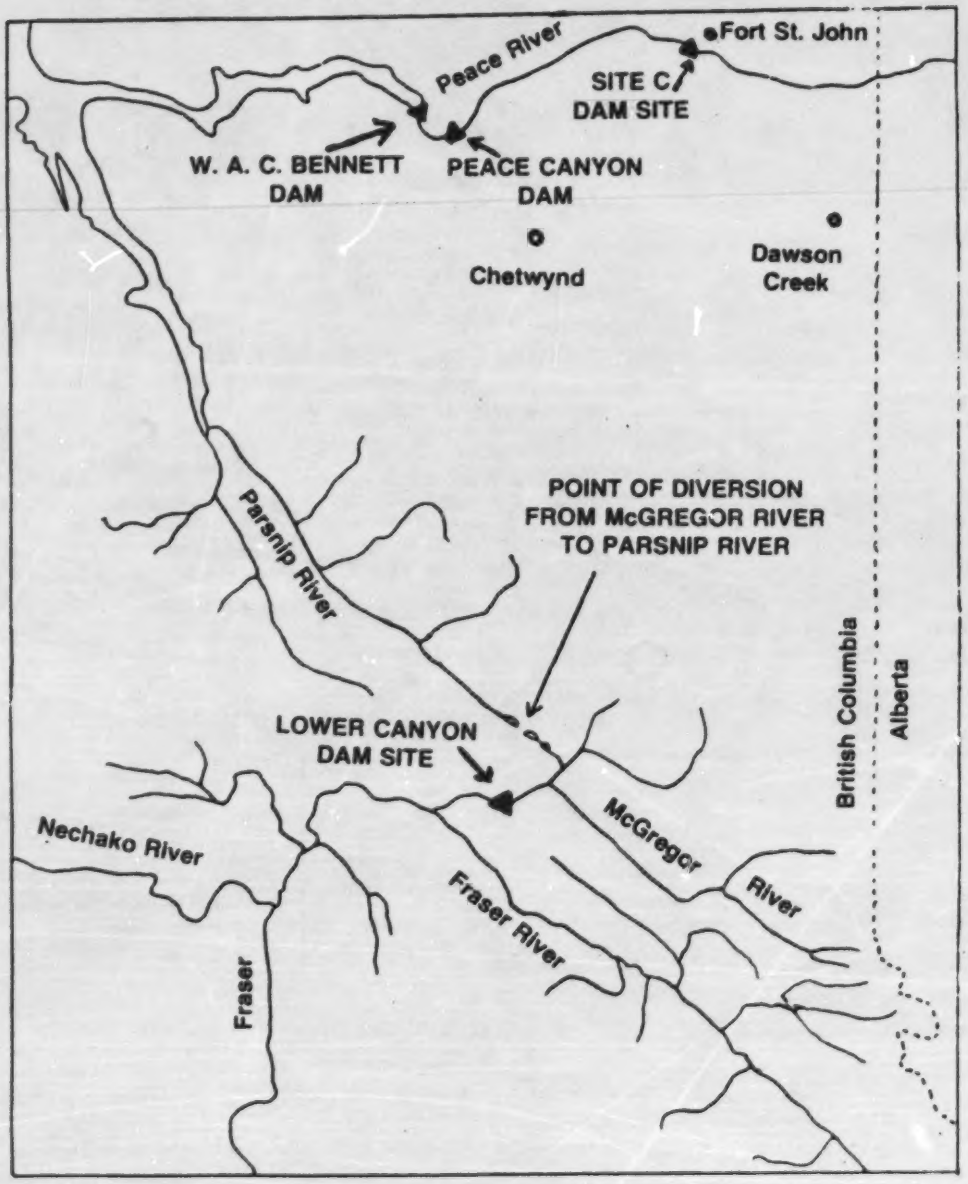
Drawing by Angus Gunn Jr.

The Rockies collect substantial amounts of moisture during the year. In winter the moisture is stored in the form of snow, then released in summer in volumes depending on the speed with which the temperature rises.

Questions

1. Explain how the McGregor Diversion project could reduce the risk of serious flooding in the Lower Fraser.
2. Why is the danger of flooding greatest in summer when there is least rainfall? How fast must the water travel if it crests in Prince George in the first week of June and peaks at Hope in the first week of July?
3. What do you think of the McGregor Diversion idea? Do you think it should be revived now that some time has elapsed? Tell us what you think. Write to: Topic Today, c/o The Province, 2250 Granville St., Vancouver, B.C. V6H 3G2.

McGREGOR DIVERSION



McGREGOR DIVERSION SIMULATION

The simulation places the students in the roles of a community group faced with the task of weighing the advantages and disadvantages of the project, the benefits of flood control and power against possible damage to the environment, then coming up with a recommendation that is passed on to a higher authority -- simulated by the class acting as the B.C. Provincial Legislature.

There are three possibilities open to the authorities concerned and the students, representing different community interests, have to make their recommendations on one of these three. The roles they assume for this purpose are varied;

eg. MAY O'RALTY, Mayor of Mission

ECOLLO GEE, B.C. Wildlife Federation Inspector

KILO WATT, B.C. Hydro Representative

LOTSA MONEY, President, Prince George Chamber of Commerce

i) Go ahead as planned. This assumes that the parasite problem will not prove to be serious. Advantages are twofold -- low cost electrical power, reduction of flood risks.

ii) Delay the project to allow time to get rid of the parasites or prove that they do not present a serious threat. Advantages here are that extra protection is being provided for sports fishing in the Peace system. Disadvantages are that there would be some increase in costs because of the delay.

iii) Cancel outright and propose an alternative from one of the following available options:

-coal -nuclear -northern river

Advantages are that the total parasite problem is eliminated and the preservation of lifestyles for local trappers and recreationalists. Disadvantages are higher costs of electrical power plus the continuing risk of extensive flood damage.

A sequence of six or more lessons is recommended, as follows:

1. Introduction to sources of energy in the province
2. Allocation of roles by arranging the class into identical groups
3. Study the diversion project
4. Groups work independently to make their decisions
5. Reporting back to the full class
6. Outcome discussions or further study

Alcan story: Chapter 2

By ANGUS GUNN

IN 1948, at the request of the provincial government, Alcan began exploratory studies in the B.C. northwest with a view to building an aluminum smelter.

Six years and half a billion dollars later the first phase of the Kitimat smelter was in operation.

It was a massive undertaking by any standard; the largest job ever undertaken in Canada by private enterprise. At the time it was hailed as the kind of venture that would herald the dreams of development for northern B.C.

The language of the early fifties in the various reports on Kitimat was fascinating. Alcan had conquered the wilderness that was waiting for this kind of development. At last the wasted waters of the Nechako could be harnessed to a useful purpose.

The hydroelectric potential of the Tahtsa 16 km (10 miles) from the sea and .8 km (half a mile) above it — could at last be exploited. What seemed an impossibility a few years earlier, because of the large scale of the project, had become a reality.

A generation later, in the late seventies, the same corporation that had been so much admired in the fifties was under attack.

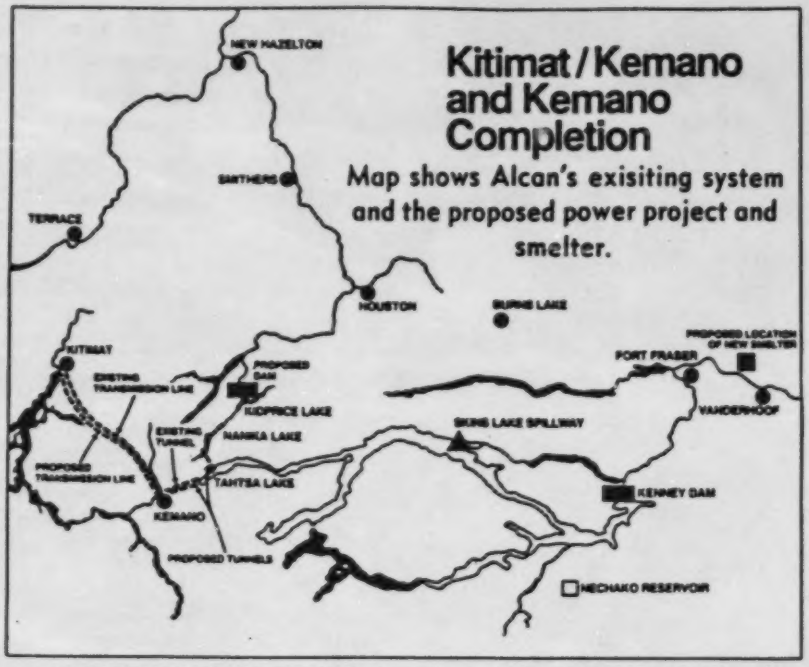
Alcan had been crystal clear from the beginning that it undertook the enormous risks on condition that it could some day expand its northwest operations to the originally proposed limit of half a million tonnes. Present cuput at the Kitimat site is approximately half of that total.

Understandably there was frustration and strong reaction on Alcan's part as it became clear that the rules of the game had changed in the intervening years.

The legal contract with the government had experienced a sort of metamorphosis. Emerging lifestyle values and concerns for fish and wildlife now claimed a new priority.

Alcan's second response was a dramatic shift from its planned course of expansion to an alignment with the new environment, to a reassessment of the whole basis of industrial development in the northwest.

In the words of Alcan's vice-president for B.C.: "We have been persuaded that total diversion of the two river watersheds, as granted by our licence, is not a realistic goal. Our new approach calls for a shared resource."



The new partnership between business and environmentalists has yet to be worked out but clearly eyebrows have already been raised at the extraordinary shift in outlook by a colossus like Alcan.

One open-line radio host in Prince Rupert put this way: "It's a new company almost. They're listening to the ranchers. They're meeting with the sports fishermen, they're meeting with various groups, chambers of commerce, town councils, etc."

The first move by Alcan to come to terms with the new environment was to commission a wide-ranging series of baseline studies covering hydrology, fish and wildlife resources, forestry, vegetation, agriculture, recreation and heritage.

In all, 13 volumes of research emerged with more than 1,500 pages of descriptions, statistics, and maps; these would provide a data base to assist in redesigning new developments.

The net result will be exactly what is needed, if the reality of a shared resource is to emerge, perhaps for the first time in a large B.C. community.

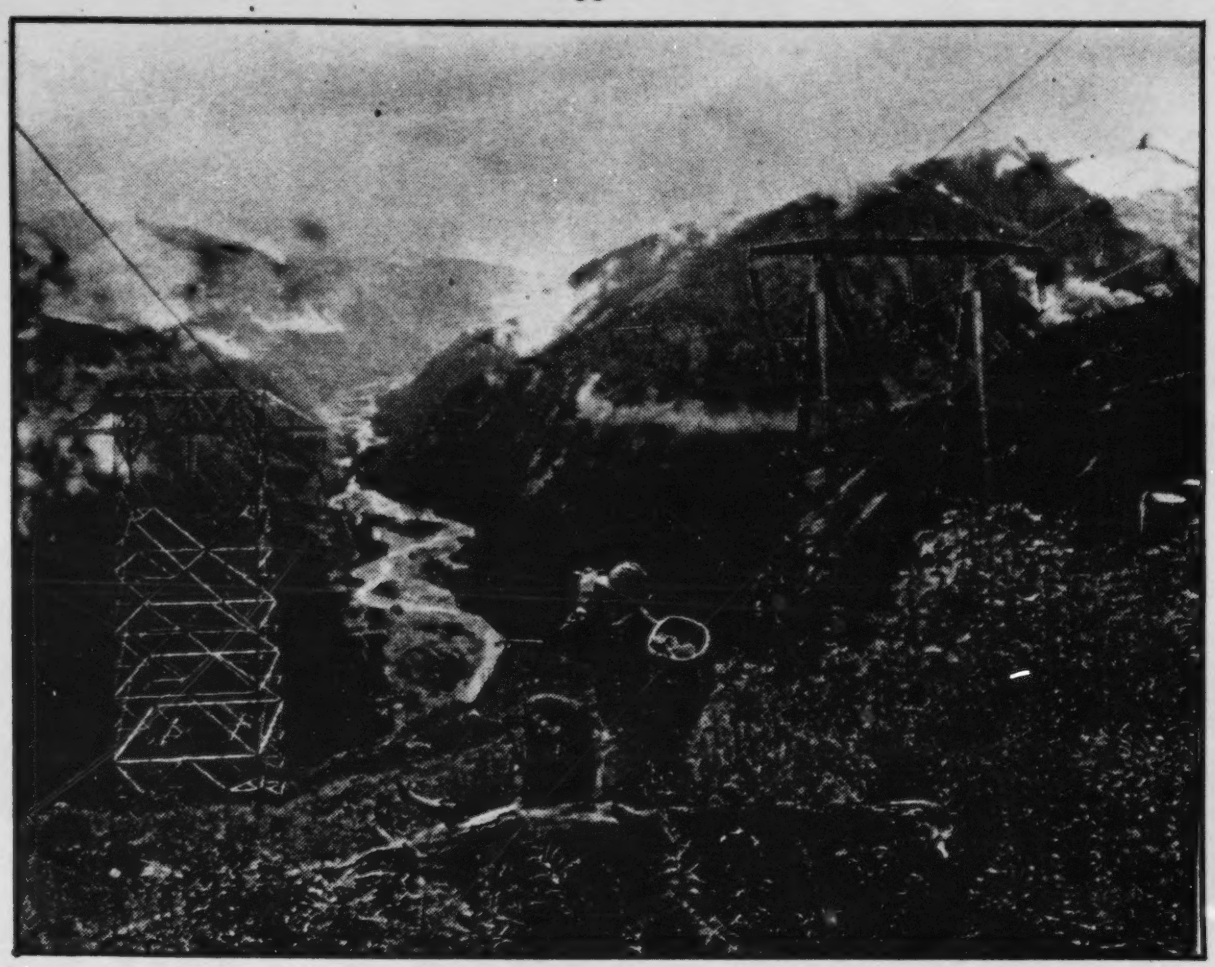
Groups of people and individuals of varied backgrounds have become involved; there have been public meetings, press reports, radio talk shows and correspondence. It all adds up to the kind of participatory decision-making that we can expect to be the norm for the eighties.

A caller on a talk show is concerned about the danger to fish stocks if only the minimum amount of water is released from the reservoir and there happens to be a dry year.

Alcan's response is that the danger would be far greater if there were no storage. Since the reservoir is very large, additional water can be released in a dry summer without losing any of the hydroelectric power potential. A smaller reservoir could not do this.

The loss of familiar landmarks, the nostalgia of recreational history are the sorts of things that no amount of assurance of jobs, technical training and growth of community services can erase.

There are nature lovers who are deeply attached to the status quo everywhere. Theirs are the sorts of values that have to placed alongside those of the newcomers, the jobless, the entrepreneurs and some sort of compromise worked out.



Checking transmission lines at mile-high Kildala Pass between Kemano and Kitimat.

Questions

1. What advantages for hydroelectric power generation exist in the Kemano/Tahtsa Lake area?
2. Find out all you can about the processes involved in producing aluminum.
3. Alcan has plans to build a third smelter somewhere in the northwest (first one was at Kitimat; second proposed one may be in the Vanderhoof area); where is the best site for a third? Tell us the reasons for your choice.

TEACHERS

To order a weekly class set of no fewer than 10 copies of The Province (at half price delivered to the school), call Vancouver 732-2419.

This material was compiled by Angus Gunn, professor of Education at the University of British Columbia.

STUDENTS SPEAK UP

ELEVEN OF John Eggleton's students at Kinnaird School, Castlegar, wrote us in response to our question: "Should we sell water to the U.S.?"

The letters came from Nicola Bullock, Sarah Finney, Gordon Gjennestad, Kari Hartman, Maya Kalmakou, John Mathieson, Tami O'Connor, Brent Pinckney, Jason Sallilstrom, Chris Sharp and Cheratra Yaswen. We have space for only a few of them:

"I do not think we should sell our water to the Americans; the way our country is prospering I predict we will need much more water in the future for new mills, factories and dams." — **Gordon Gjennestad**

"I personally believe that if we don't give water we are being selfish. Why not sell some? Our economy might improve. Canada relies heavily on Americans." — **Tami O'Connor**

"In my opinion we should sell water to the U.S. on a temporary basis, until we need it, or we are out of the recession, whichever comes first." — **Brent Pinckney**

"If we sell water to the U.S. we will be in big trouble. In the next few years our population will be much greater, so we will need more water for industrial, hydroelectric and recreational uses." — **Jason Sallilstrom**

"It is a well known fact that most of Canada's fresh water is in the North where we cannot get it cheaply. If we sell our accessible fresh water to the U.S. it will cost us dearly to replace it." — **Cheratra Yaswen**

ENVIRONMENT AND "PEOPLE VALUES"

Update on the Kemano Completion Project

Residents of North Central B.C., especially those in communities along the Nechako River, have sometimes expressed concern that the Kemano Completion Project will seriously affect the river and the quality of life enjoyed. Concerns have also been expressed by the Department of Fisheries and Oceans, the federal government agency which has responsibility for salmon, the International Pacific Salmon Fisheries Commission and the Provincial Fish and Wildlife Branch. The DFO has responsibility for chinook salmon which spawn in the river, while the IPSFC is concerned with the sockeye salmon which use the river as a migratory route to their spawning beds in other rivers. The Fish and Wildlife Branch is responsible for fish resident in the river.

The concerns about the salmon focus mainly on two things: adequate volume of water in the river and sufficiently low temperatures in the hot summer months. Alcan feels that the flow regime provided throughout the year for the various life cycle phases would adequately protect the salmon.

With water from natural tributaries, the average annual flow at Vanderhoof would be about 71 m^3/sec. In early summer, at the gauge at the old Vanderhoof Bridge, the river will be more than 100 m wide and 3 m deep. These flows are similar to those at such other well known salmon rivers as the Chilliwack at Vedder Crossing, the Adams and the Bowron at Hansard.

With regard to temperature, the Federal Department of Fisheries and Oceans believes that the risk to salmon increases significantly when they are subjected to water temperatures above 20°C, and states that action needs to be taken to limit exposure above that temperature. Alcan proposes to reduce the frequency of exposure to temperatures above 20°C and with the proposed solution any improvements in weather forecasting will limit the exposure even more.

In the Nechako River drainage, the sockeye are close to the extreme range of the migration routes for Fraser River stocks, and are accustomed to encountering high water temperatures in the natural uncontrolled rivers. Alcan's proposal of a cold water release would result in a Nechako temperature regime that is cooler than it has been for the past 30 years. The proposal would also give the Nechako a cooler temperature regime than that of the Stuart, a nearby natural uncontrolled river into which the sockeye also pass.

The facility that Alcan would construct to regulate the temperature will be a bypass tunnel around the Kenney Dam. This would permit cold water from the depths of the Nechako reservoir to be discharged into the river during periods of hot weather, instead of the surface, warmer water used previously. This ia a solution that the IPSFC and the Department of Fisheries and Oceans (DFO) recommended to Alcan thirty years ago when the initial phases of the power project were first undertaken. Because it is colder, the volume of water would be considerably less than that formerly released through Skins Lake Spillway, the discharge control point on the Nechako River reservoir. This will be welcomed by those who have experienced problems of erosion and flooding in the past years.

There are three life phases for the chinook salmon in the river which have to be considered -- spawning, incubation and rearing. Surveys of spawning areas have shown that Alcan's proposal of 14 m^3/sec from December through March is more than sufficient to keep the redds well covered during incubation.

During winter, incubating salmon eggs must have a protective cover of water at all times. In natural, uncontrolled rivers, there is a significant flow reduction during the winter, with the attendant risk of eggs freezing if spawning redds dry out and become exposed to cold air. The spawning incubation flow ratio of 2:1 in the Nechako which would result from the Alcan proposal would be better than that achieved by unregulated rivers in North Central British Columbia.

Rigorous habitat evaluation work has shown that a normal rearing habitat is available at a flow of 30-33 m^3/sec., the same basic flow that the DFO has viewed as necessary for migrating and spawning adults. Alcan has therefore decided to propose this flow for the entire spring and summer and early fall months. In so doing adequate flows of water are maintained for a variety of recreational activities -- fishing, hunting, and the landing and take-off of float planes.

FINDING OUT

Choose any lake, natural or man-made, and take the viewpoint of one of the following. Write down the things you want from the lake and its surroundings. With which of the other viewpoints does your interest most conflict?

1. Owner of a summer cottage, a naturalist
2. Farmer
3. Sports fisherman
4. Canoeist
5. Motel owner with power boats
6. Factory owner
7. Mayor of neighbouring small town
8. New subdivision developer.

For power and people

The Stikine potential

By ANGUS GUNN

ON THE WESTERN portion of the Stikine Plateau, in a remote, almost inaccessible wilderness area 400 kilometres (640 miles) north of Prince Rupert, the Stikine River plunges toward the coast through the 90-km (144-mile) long Grand Canyon west of Dease Lake and north of Telegraph Creek.

It is a most attractive prospect for a hydroelectric power project and B.C. Hydro is actively examining it; nowhere else in B.C. is so much power potentially available for the same cost.

When coupled with its tributary, the Iskut, the two rivers could produce more electricity than the G.M. Shrum on the Peace which presently provides 40 per cent of all B.C.'s electricity.

The Stikine is an international river, like the Columbia but with a big difference; there are few people in its valley and fewer still affected by its downstream performance. Almost all concerns focus on the chinook salmon fishery.

About 35 km (22 miles) from its mouth, the Stikine crosses the U.S.-Canada border on the Alaska Panhandle; it's probably one of the least guarded international borders in the world, one where movement up and down the river is virtually free from all constraint.

The Iskut is the Stikine's main tributary with a 120-metre (394-foot) deep canyon located about 80 km (128 miles) from the point where the rivers join. The canyon drops as much as 140 m (459 feet) within a length of five kilometres (three miles); hence its suitability for a hydro dam.

All four proposed damsites lie above the salmon runs, a result of the barrier effect of the canyons. Impacts on the chinook salmon are therefore limited to those caused by interference with the normal flow of the rivers.

Salmon have a special place in the lore of B.C.; they were the staple food of its native people a thousand years ago and they still give rise to legal battles over native rights. They have been a vital part of the provincial economy and are today the chief quest of sport fishermen; so anything and anyone that endangers them must face stiff opposition.

Map of the Stikine-Iskut area shows the sites of proposed hydroelectric dams on the Stikine and the proposed diversion dam on Forrest Kerr Creek.

In Alaskan waters the annual catch of the Stikine chinook often reaches 10,000 fish; native people in the Telegraph Creek area may take less than 500 annually but because of their traditional rights, this resource is important.

B.C. Hydro, aware of changing environmental concerns, has done its homework. Two years of environmental studies have just been completed. They include assessments of all forms of fish and wildlife that might be affected by dams, tourist and recreational interests, forestry, archeological sites, settlements and so on.

Fluctuations in river flows due to the dams can affect the chinook salmon in several ways: water temperature may change; spawning grounds may be shifted as a result of reduced sediment in the river; and water volumes can be increased almost moment by moment depending on the changing patterns of electricity demands.

These are not new; they have been known for some time. The new element in the Stikine project is the determination of B.C. Hydro to take account of the importance of the salmon by designing costly corrective measures long before they plan to dam the rivers.

Besides the salmon problem there are other concerns: loss of productive forest resources amounting to about 1½ per cent of the total available: loss of four archeological sites, disruption of

Mountain goats near Grand Canyon on the Stikine.

A reader writes in response to our question: What kind of electric generators should we be using?

I am wondering why there is little mention of modern methods of generating power, methods that must be part of our lifestyle in the immediate future. As I understand the situation, the costs of producing power from different sources run as follows:

	Cost per power unit
Conventional generation (hydro and fossil fuel)	0.05
Nuclear generation	0.06
Space-bound generation using the sun as power source	0.065
Earth-bound generation using the sun as power source	0.07

moose, caribou and mountain goat habitats and partial loss of the scenic values in the Stikine canyon area.

There is an international dimension to the Stikine project. Instead of the strident voices we have heard at the Site "C" hearings advocating opposite approaches to the project, there have been extended, intensive discussions at Petersburg and Wrangell seeking ways to give adequate consideration to all interests.

Representatives of federal and state agencies, members of the public and members of the Alaska Native Brotherhood have attended. Perhaps the camaraderie being generated will spill over into the acrimonious Skagit issue.

A STIKINE HISTORY

1793 — Earliest white contact with the area by Captain George Vancouver, although he did not recognize the river at that time.

1824 — Samuel Black of the Hudson's Bay Company reaches the Stikine by an overland route.

1825 — British-Russian agreement by which the Russians retained the "Panhandle" area, the boundary being defined by the crest of the mountains running parallel to the coast.

1861 — Gold discovered on the Stikine.

1862 — British Colonial Office assigned control of the Stikine Territory to the Colony of British Columbia.

1866 — In expectation that the place would be a significant station on Collin's Overland Telegraph, Telegraph Creek was named.

1867 — United States buys Alaska from the Russians; this resulted in a series of border disputes between Britain and the U.S. as to the exact location of the boundary.

1876 — Boundary of the Panhandle finally settled.

1896 — Stikine River-Dease Lake trail becomes a major route to the Klondike gold fields.

1900 — Federal government constructs a telegraph line to Telegraph Creek and on to the Yukon gold fields, leading to the establishment of Telegraph Creek as the only major population centre on the Stikine.

Question

1. Why should the boundary originally established between Britain and Russia cause trouble after the purchase of Alaska by the United States?
2. If a river is dammed for hydroelectric power purposes, should the river not return to its normal pattern of flow after the dam is completely filled?
3. By building a dam on the Grand Canyon, access to this wilderness area is made possible for many more people than would otherwise see it. Is this preferable to leaving it as it is for the use of the very few who are able to get to it?

New watermain links Capilano Reservoir with English Bay area.

B.C. is blessed

WHEN A Chinese delegation recently visited Vancouver, their accolades were not directed at the beauty of the setting, the tall buildings or even the people; it was the clear, tasty water that gripped their interest.

The reason for the good water is the unusual isolation and exclusive control of the source. In the North Shore mountains there are 579 km² (226 square miles) of uninhabited land, fully controlled by the water district.

No one is allowed into the area except on special permits, and guards are stationed at the entrances to enforce this exclusion.

Within the source area, water is stored in several natural lakes and behind two dams, the Seymour and the Cleveland. From these storage locations water is piped across Burrard Inlet at the first and second narrows into Vancouver and surrounding municipalities.

With such exclusive control of the water, very little chlorination is needed; the average annual precipitation of 368 cm (145 inches) ensures that low levels in the lakes rarely prove to be a problem.

Selective logging, with reforestation, improves the water-yielding characteristics of the catchment area; these activities also control insect infestation.

The big future challenge is the growing rate of consumption; in the time taken for Metro Vancouver's population to climb 50 per cent, the per-capita water consumption has doubled.

At this rate, how long can we keep the high quality of our fresh water supplies?

Questions

1. Make a list of 10 important uses of water; include recreational, industrial, home, transportation and agricultural uses.
2. What do you think about the idea of charging more for the water we use in the home in order to encourage conservation?
3. A Kamloops inventor has devised an attachment for toilets which could substantially reduce fresh water consumption in homes and, at the same time, reduce the amount of waste water dumped into rivers. Suggest other conservation measures that could be used to achieve the same purposes.

Water:

By ANGUS GUNN

WATER HAS served a thousand purposes in the life of the people of British Columbia; the first explorers found their way here via rivers and ocean; the natives concentrated their settlements near water and in areas of highest rainfall; the first industrial and commercial undertakings used the power of falling water as their source of energy.

In these early days, when water for home use had to be carried or pumped from the nearest source, consumption was less than 20 litres (4½ gallons) a day.

Today, with the demands of urban society, more than 10 times that amount is needed. To wash the dishes in an average home you need 45 litres (10 gallons); twice that amount goes down the drain when you have a bath; even flushing the toilet once uses up more than twice the total daily consumption of a pioneer family.

More than a billion litres a day are drawn from rivers and storage reservoirs to provide for home use, with nine tenths of that amount being used in B.C.'s urban areas.

Although this amount is only a small fraction of the total consumption, it is rapidly growing. It is a reminder of the need for better conservation of the billions of litres of water that daily hurtle down the mountain sides into the sea.

Water comes to B.C. in abundance. If it were all distributed evenly it would give us 10 cm (four inches) province wide; but it is very uneven, ranging from 650 cm (256 inches) in spots on the west coast of Vancouver Island to less than 20 cm (eight inches) in the Interior.

Seasonal variations further complicate distribution; some places have dry summers and wet winters, others have an opposite regime; and over the longer term there are multi-year climatic cycles.

Water control is therefore essential to ensure adequate reserves for the farmer for irrigation when water levels drop, to maintain a high enough head of water for electrical generation when a cold spell raises demand and to provide supplementary flows in rivers in dry seasons so that the salmon can get to their spawning grounds.

Water control is normally

A precious commodity

Recreational use of water takes many forms like whitewater kayaking.

achieved by storage. The natural systems are swamps, snow fields, ice fields, lakes, groundwater. These are vital and need to be preserved; but they are far from adequate in an area where rivers have ratios of 101 to 1 as between seasonal highs and lows in their volumes of water as in the Skeena River.

By comparison, the St. Lawrence has a ratio of 2 to 1.

Water use is normally only applied to withdrawal activities: that is to say, those activities which take water away from their normal setting and later return part of the water taken, often in a less pure state.

Hydroelectric power generation is not included in water use since no water is withdrawn from its normal setting and since water quality is unaffected.

The usual uses affecting water quantity and quality are: Municipal — for domestic, commercial, and public institutional interests; agricultural, generally for irrigation; industrial; and thermal (generation of electricity).

Compared with other parts of the country, thermal electricity generation in B.C. is limited.

Primary and secondary industry are major users of water in B.C. Together they use more than half of the total. Agricultural and municipal uses account for about one quarter of the total.

Since most of the manufacturing activities are concentrated in metropolitan Vancouver, it is there that water problems arise.

These problems are twofold: the increase in water usage as a result of population growth and rising standards of living; the increasing use of new products which have affected water quality.

The effect of the first has been to step up demand for water both for domestic and for recreational uses; the effect of the second has been to heighten concern about the health hazards of urban water supplies.

The hazards of urban water quality are likely to dominate the list of water use concerns for some time.

Take, for example, the million and a quarter people who live in the Lower Fraser Valley, the land area bordering the Fraser between Hope and the sea. Virtually all of these people use the river in one way or another.

The forest industry transports and stores logs on the river, ships use it as a main ocean highway, industries draw from it for their manufacturing processes and salmon pass through it in their millions on their way to spawning grounds.

Wildlife habitats are located in and beside it, people use it for recreational purposes; perhaps most significant of all, it is the carrier of all the wastes of the region.

It is these wastes that are raising the question of health hazards.

Fundamental values are involved in the solution to this growing problem. The waste dischargers are not a handful of sources that could readily be controlled. They involve the many thousands of households that discharge sewage into the river. They are the motorists whose exhausts produce chemical fallout that eventually reaches the river; they are the home gardeners whose pesticides wash into storm sewers.

Perhaps if the true money value of water were applied to its use we might see a change in the prodigal uses of the present time. Some surveys have shown that people are willing to pay more for better quality water.

How much more? Costs at present run at about one hundredth of one cent per litre; gasoline is more than 40 cents a litre. Who can say that gasoline is more valuable than water?

MINI TEST

(Answers Below)

1. Which of the following characteristics of a river are best suited for development of hydroelectric power?

A. Slow-flowing water in a narrow gorge
B. Fast-flowing shallow water in a wide channel
C. Deep, slow-flowing water on level land
D. Fast-flowing water in a narrow gorge

2. Prime power at run-of-river plants is based upon the river's

A. Peak flow
B. Minimum flow
C. Average flow
D. Hydrologic Head

3. The advantages of hydroelectric power generation over other sources of power include all of the following EXCEPT:

A. Its source of energy is not destroyed
B. It provides flexibility of location
C. It provides possibilities of multipurpose development
D. Its cost of up-keep is low

4. Costs involved in developing hydroelectric power are mainly

A. Operating costs after construction
B. Maintenance costs for equipment
C. Construction costs
D. Costs for purchase of land

5. The increase on the generation of hydroelectric power in recent years is due in part to

A. The discovery of progressively better locations
B. An improvement in the capabilities for transmission
C. A decrease in the cost of building dams
D. The inefficiency of thermal projects

ANSWERS (invert)

1. D 2. B 3. B 4. C 5. B